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ABSTRACT

Prepared to aid in the planning and initiation of radiologic technology programs in community colleges and vocational technical schools, this curriculum guide should be useful to school administrators, advisory committees, and faculty, and may be modified to meet local, state, and regional needs. It contains full descriptions of 22 course offerings (covering the majority of the document), and examples of texts, equipment and costs, and library, faculty, and student qualifications. Included are a bibliography and eight appendixes which present (1) information on The American Registry of Radiologic Technology, (2) a guide for writing contractual agreements in instances of hospital-college affiliation, (3) a glossary, (4) a description of organizations concerned in educational programs in radiologic technology, (5) evaluation procedures for college sponsored programs in radiologic technology, (6) criteria for identifying the sponsor of an education program, (7) procedure for accreditation, and (8) a registry requirement change as of 1974. (HD)

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ED131256

MEDICAL RADIOLOGIC TECHNOLOGY

A Suggested Two-Year Post High School Curriculum

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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A Suggested Two-Year Post High School Curriculum

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FOREWORD

Since the discovery of x-rays in 1895, their use has grown immensely. The value of being able to see the internal structure of the living organism was quickly recognized by physicians. It is in the practice of medicine that the greatest use is made of x-rays. In the period since their discovery, thousands of uses for x-ray have been developed. The discovery of additional sources of radiation has greatly expanded the science of radiology.

As the science of radiology has grown in use and complexity, the demand for personnel skilled in the techniques of radiation procedures also grew. The science of x-ray technology involves a combination of manual skills and knowledge of theory. The need for personnel with these skills and knowledge has initiated alliances of educator and practitioner; school and hospital.

This suggested curriculum guide was prepared to aid the planning and initiation of Radiologic Technology programs in community colleges and vocational-technical schools to meet the need for qualified Radiologic Technologists.

This guide is for a 2-year post high school curriculum. It contains course outlines, examples of texts and references, sequence of technical education, laboratory plans including equipment and costs, library, faculty, and student qualifications. It is designed to assist school administrators, advisory committees, and faculty in developing or evaluating programs in radiologic technology.

The thinking and experience of many radiologic technologists, radiologists, administrators, and teachers in schools of radiologic technology are included in the guide. Although all suggestions could not be incorporated, each was carefully considered in light of the publication's intended use. In view of this, it should not be inferred the curriculum is completely endorsed by any one institution, agency or person. The publication should be used as a guide. It may be modified by administrators and their advisers to meet local, state and regional needs.

The project staff who developed the guide were members of the Department of Radiologic Technology, with Phyllis McEnerney serving as the chief investigator, and Dwayne J. Ter Mart as the assistant investigator. Harry E. Davis, of the Bi-State Regional Medical Program, served as the assistant project director. Personnel in the U.S. Office of Education who provided assistance were William Berndt, the project officer, and Helen K. Powers, Education Program Specialist.

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THE RADIOLOGIC TECHNOLOGY PROGRAM

X-rays were discovered in 1895 by Dr. Wilhelm Conrad Roentgen, a physics professor at the University of Wurzburg, in Germany. The medical value of this discovery was quickly realized, and physicians learned to operate this early, crude, often hazardous equipment. As a number of applications developed, the use of x-ray became a specialty field of medical practice: *radiology*. The physicians who specialize in this type of medical practice are called radiologists.

During the early years of x-ray, radiologists performed all the work of this specialty. As the equipment became more sophisticated and additional uses, diagnostic and therapeutic, were developed, radiologists began to train assistants to perform the technical duties connected with the use of x-ray.

X-ray machines became more powerful, allowing additional uses and demanding greater knowledge of those who used them. The training of x-ray technicians improved; and due to the increased body of knowledge, the period of training was extended.

During this period of development of x-ray equipment, other sources of *radiant energy* were discovered. As medical uses for these additional forms of radiant energy were developed, it followed that much of this work was performed by those most familiar with *radiation*, the radiologist and his assistant, the x-ray technician. Again, the training of the technician was modified to acquaint him with the uses of these newer forms of radiation. Today, such terms as *radioisotopes*, *cobalt therapy*, and *nuclear radiation*—all developments of man's experiments with the atom—are heard daily in modern radiology laboratories. In recent years, to reflect these new duties and this new knowledge required of the technician, the name has been changed from "x-ray technician" to "radiologic technologist."

Today, there are three disciplines in radiologic technology. The first, radiation therapy, involves the use of radiant energy such as x-ray, radium, cobalt, and other sources of *ionizing radiation* to treat diseases. The second, nuclear medicine, is the science of using *radioactive isotopes* of various elements to diagnose and treat various diseases. The third discipline, the use of x-rays for diagnosis, is the oldest and still comprises the bulk of the work in radiologic technology. In x-ray technology, the technologist positions the patient, determines the proper exposure factors, and processes the exposed x-ray film. In addition, the technologist directly assists the radiologist during fluroscopy and special procedures, maintains patient records, and instructs the patient in order to promote accurate results and to reduce anxiety.

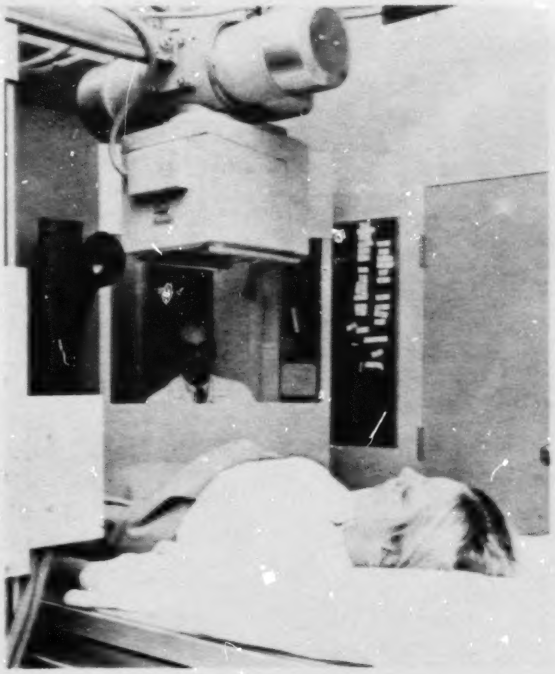

Figure 1.—Patient being examined by radiologist using modern remote-control radiographic equipment.

At the present time, there are a variety of educational programs for radiologic technology. The largest in number are the hospital-based programs offering both didactic and practical experience over a 24-month period. This type of program offers opportunity for maximum correlation of theory and practice, since the training is entirely accomplished within the hospital radiology department. These programs have the disadvantage of adding to the increase of high hospital costs, which are reflected to a great extent in patient charges.

A large number of young men are trained in radiologic technology by the military services. With the national shortage of technologists, greater emphasis must be placed upon the utilization of their skills in civilian life.

Note to reader: Words in italics will be found in Glossary, Appendix C.

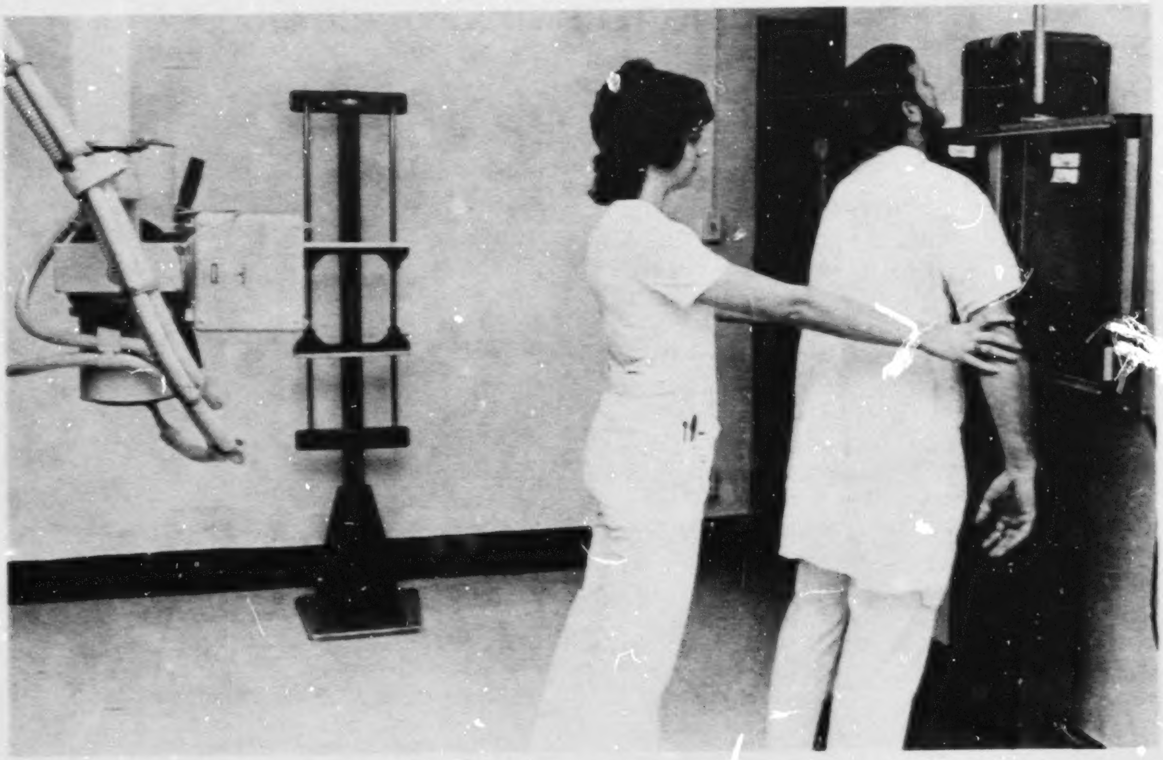

Figure 2.—Routine diagnostic radiographic equipment. Here a student positions a patient for a chest *radiograph.*

The few baccalaureate and master's degree programs not only train staff technologists but also offer advanced study in education, administration, and technical specialty areas, such as nuclear medicine, radiation therapy, special procedures, pediatrics, and radiologist assistants.

Community and junior colleges have recently turned their attentions to this technical education field. Due to the proliferation of these institutions, the greatest growth in numbers of new programs is occurring in the two-year college. This type of program, when well structured and implemented, shows great promise in fulfilling student needs and assisting in the alleviation of hospital personnel shortages. The broad tax base supporting these institutions adds the advantage of low-cost education without excessive financial burden to any special group, such as hospital patients.

GENERAL CONSIDERATIONS

This guide has been prepared for educational administrators and planners, health facility administrators and other professional or technical people interested in establishing or strengthening programs in radiologic technology.

The guide is formulated on the assumption that strong programs are possible only through the cooperative effort of the educator and the health professional, the school and health facility. As a foundation for their planning, planners must have available the best information pertinent to existing programs.

The guide was prepared following extensive study, including visits to many outstanding schools providing programs in radiologic technology. Consultations with educators, administrators, radiologists, technologists and other health personnel were conducted; and the many facets of educational programs were explored with these individuals. All have contributed to and shaped the content of this guide.

Educators using this guide to develop new programs may wish to tailor the recommendations to local conditions or specific needs. Changes should be considered only with the advice and consultation of local advisory committees (see page 56). These committees may also perform invaluable service by guiding the important studies necessary to determine the degree of local need and the availability of

Figure 3.—Radiologic technologists must have a thorough knowledge of anatomy. These students are identifying structures of a skeletal skull in an anatomy laboratory.

facilities and teaching personnel necessary for a successful program and evaluation of existing programs. Program planners must be aware of the special skills, abilities, and knowledge required of the technologist and the nature of the tasks they may be called upon to perform.

THE EDUCATIONAL PROGRAMS: RADIOLOGIC TECHNOLOGY

At the present time, the majority of radiologic technologists are graduates of hospital-based programs. These programs are conducted wholly within the operational area of the radiologic or x-ray department of the hospital. They have developed from the on-the-job type of training, wherein the student learns from those practicing the science through exposure to this practice.

In recent years some of the hospital-based programs have affiliated with colleges to form hospital-based college-affiliated programs. In this type of training, the student in radiologic technology attends the college for general educational courses. The didactic portion of the technical courses, as well as the practical experience, is maintained in the hospital just as in the hospital-based programs.

The present trend in educating the technologist is the educational institution-based program. This places a great responsibility upon the hospital to provide a meaningful clinical experience for the students and upon the college to provide not only the general education portion of the program but college-level technical courses in all phases of this technology.

Other types of programs which should be mentioned are the baccalaureate and military programs. The baccalaureate program is an extension of the two-year curriculum. The military program, depending upon the training received, must be evaluated on an individual basis.

Hospital-Based Programs

The logical place for the early development of programs in radiologic technology was in the hospital. The hospital department of radiology employed the greatest number of trained technicians, thus had the highest motivation for establishing programs. For the most part, hospital laboratories were the only places having the equipment needed in all aspects of supervised clinical experience. Finally, hospital x-ray departments are normally the only places having a sufficient volume of diverse procedures necessary to supply this most important phase of clinical practice. It can easily be seen that the original impetus for training was in the hospital-based programs, and it is understandable that by far the largest number of technologists still receive their training in this way.

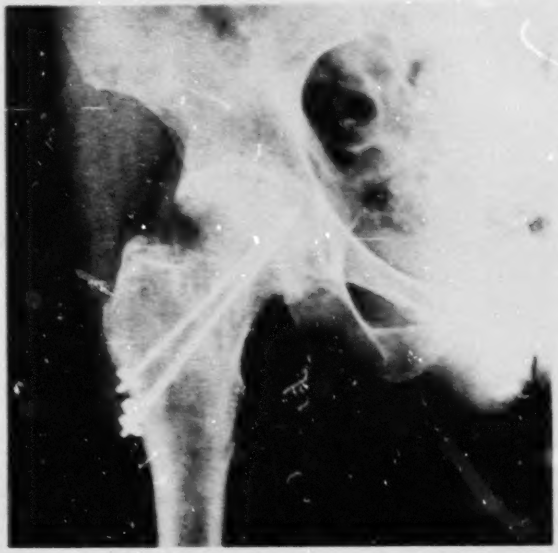

Figure 4.—Students receive experience in the operating room. This radiograph demonstrates a hip which was pinned during a surgical procedure.

Figure 5.—Pediatric radiography is one phase of practical experience obtained in a hospital-based program. Here students are preparing to radiograph a child.

The hospital-based programs offer certain advantages. The major advantages are:

1. Expensive equipment needed for the practice of radiology can also be utilized for training.
2. Direct costs to the student are usually low or non-existent.

The hospital-based program also suffers some disadvantages:

1. Costs of the training must be absorbed by the hospital, thus increasing the cost of medical care.
2. The knowledge the student gains in the sciences is normally not applicable for college credit.

Educational Institution-Based Programs

This type of program is conducted primarily within the educational institution, retaining the hospital affiliation for the essential clinical *practicum*. While this type of program results in increased equipment and faculty costs to the educational institution, it offers a number of advantages:

1. Hospital costs for the program may be reduced.
2. Greater numbers of students can be taught per campus laboratory area.
3. Students receive greater academic recognition for their studies, which promotes the achievement of additional education.
4. Students gain a broader academic background without sacrifice of the career training.
5. Through its facilities, the educational institution can provide an increasing amount of educational experience in the fundamentals of *radiography*, lessening this responsibility upon the clinical personnel.

Baccalaureate and Military Programs

Baccalaureate programs, due to their greater length, offer additional study and options over the shorter programs. The baccalaureate student in radiologic technology may find himself better prepared for administration, teaching, radiation therapy or other specialty, depending upon the direction of his studies. These programs offer not only greater amounts of general education and supportive studies, but also more advanced specialty studies.

Programs conducted within the military provide a large number of potential working technologists within the field. Some of the military programs are approved by the American Medical Association, but in others, the necessity arises for further training in civilian institutions.

It should be noted that all the educational programs mentioned must be accredited (see Appendix D) in order to permit their graduates to qualify for

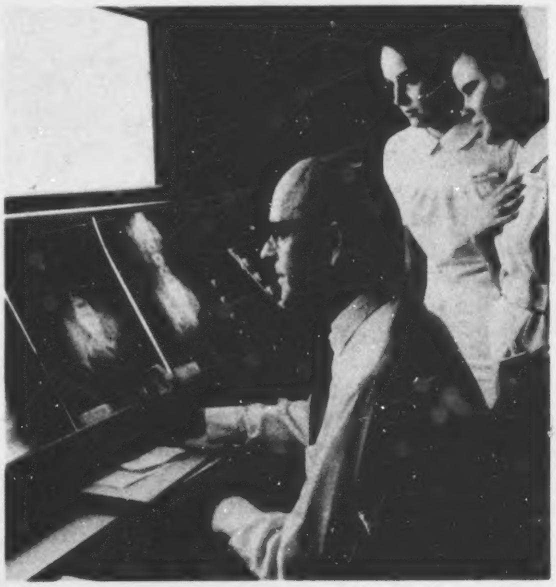

Figure 6.—In an educational institution-based program, coordination with clinical facility is most important. A radiologist is depicted instructing students in film critique.

registry examination. All educational programs must have access to a radiologic clinical facility with sufficient facilities and volume of procedures to ensure the students of adequate clinical practicum. The variety of these clinical procedures must be such that the student experiences a wide spectrum encompassing all the areas of radiologic procedures. To ensure the student of quality clinical experience, he must also be closely supervised in the clinical setting. Proper student supervision for all radiologic procedures would consist of the following:

1. Student observing the instructor
2. Student assisting the instructor, gradually superseding the technologist in the procedure
3. Instructor observing the student
4. Student doing the procedure unaided, with instructor assistance readily available when needed

EMPLOYMENT OPPORTUNITIES

Radiologic technologists enjoy a variety of career opportunities. The large majority are employed by hospital laboratories performing duties important to *radiation diagnosis* and therapy. A lesser number are employed in other areas of health care, such as physician's offices, radiology laboratories outside the hospital public health organizations, community health clinics, and veterinary offices and clinics. A minority find employment in commercial positions connected with the manufacture, distribution and servicing of radiologic equipment. A few technologists are employed in industry performing x-ray testing of materials. While salaries fluctuate according to geographic area, compensation of radiologic technologists compares favorably with that of other technical careers requiring similar periods of training and experience.

ADVANCED EDUCATION

For some of the career possibilities in radiologic technology, education beyond the basic two-year requirement for registration is desirable. Usually, examination of the performance requirements of the particular career will reveal the need for knowledge other than technical radiography skills.

Many technologists, without formal training beyond the basic two-year program, perform creditably in teaching their science. Obviously, the needed teaching skills can be developed through trial and error and polished by experience. It is recommended, however, that those technologists interested in a teaching career acquire training in these educational skills through formal education. While completion of such programs is no guarantee that the graduates will be effective teachers, the chances for success are greatly increased over any other method.

A position involving some degree of management or administration can be similarly viewed. Obviously, some administrative skill can and should be acquired through experience; however, formal training in basic theory and technique is recommended.

Although the major emphasis in radiologic technology education is concerned with routine diagnostic procedures, specialty fields within this science are gaining in importance. Technologists working in these areas must master the techniques through advanced training programs and experience. A general description of the major specialty areas follow.

Nuclear Medicine Technology

Nuclear medicine technology is the discipline concerned with diagnosis and therapy through the use of radioactive materials. The basic eligibility requirements for registration in nuclear medicine technology, as quoted from *The American Registry*

Figure 7.—One aspect of nuclear medicine technology is pictured. The technologist is demonstrating the use of a *scanner* to a student.

of Radiologic Technologists (see bibliography), is as follows:

A. Candidates must have had a high school education, or the equivalent thereof, as witnessed by such documentary evidence as the Board of Trustees shall deem acceptable.

B. Candidates must be of good moral character. Those who have been convicted of a crime must have served their entire sentence, including parole, and have had their civil rights restored.

Required education in nuclear medicine technology:

A. Basic requirements:

Candidates shall have successfully completed at least one year of training in a school of nuclear medicine technology accepted by the American Registry of Radiologic Technologists which has included didactic experience equivalent to the curriculum approved by the Council on Medical Education of the American Medical Association, the American Society of Radiologic Technologists, the American College of Radiology, and by the Registry of Medical Technologists (ASCP). In addition, candidates must meet at least one of the following sets of conditions:

1. Graduation from an AMA-approved program in x-ray technology.
2. Certification as an x-ray technologist by the ARRT.
3. Certification as a medical technologist by the Registry of Medical Technologists (ASCP).
4. Registration as a professional nurse.
5. A baccalaureate degree from an accredited institution.

B. Alternate qualifications:

As an alternate to the basic requirements, candidates may meet one of the following:

1. The successful completion of a formal course of training of at least two years in nuclear medicine technology in a school accepted by the ARRT.
2. Graduation from a four-year high school course plus at least five (5) years of full-time (40 hours per week) experience in a clinical radioisotope laboratory accepted by the ARRT.
3. Certification as an x-ray technologist by the ARRT plus at least two (2) years of full-time (40 hours per week) experience in a radioisotope laboratory accepted by the ARRT.

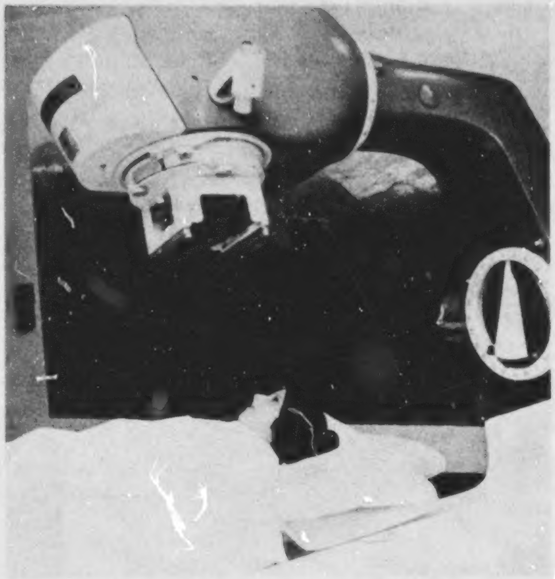

Figure 8.—Students receive a limited amount of experience in radiation therapy technology. A versatile cobalt therapy unit with wall mural in background is shown during treatment of patient.

The alternate qualifications may be altered or discontinued at the discretion of the Registry Board of Trustees.

Radiation Therapy Technology

Radiation therapy technology is the treatment of disease through exposure of affected areas of the patient's body to prescribed doses of x-ray or other forms of ionizing radiation. The radiation therapy technologist assists the radiologist through proper operation of control devices and equipment used in radiation therapy. The basic eligibility requirements for registration in radiation therapy technology are the same as the basic eligibility requirements for registration in nuclear medicine technology. Required education in radiation therapy technology, as quoted from *The American Registry of Radiologic Technologists* (see bibliography), are as follows:

A. Basic requirements:

Candidates must have successfully completed a 12-month course in a school of radiation therapy technology which has included didactic experience equivalent to the curriculum as prescribed by the American College of Radiology, The American Society of Radiologic Technologists, and the American Registry of Radiologic Technologists. In addition, a candidate must meet at least one of the following conditions:

1. Graduation from a two-year program in x-ray technology approved by the Council on Medical Education of the American Medical Association.
2. Certification as an x-ray technologist by the ARRT.
3. Certification as a nuclear medicine technologist by the ARRT.
4. Registration as a professional nurse.

B. Alternate qualifications:

As an alternative to the basic requirements, candidates may meet the requirement of the successful completion of a two-year course in a school of radiation therapy technology accepted by the ARRT.

Note: Education in radiation therapy technology, to be acceptable for these eligibility requirements, must be presented in an institution which meets the minimum standards for a major cancer management center established by the American College of Radiology.

Effective July 1, 1974, only graduates of radiation therapy schools approved by the Council of Medical Education of the American Medical Association will be accepted for examination for certification in radiation therapy technology.

Special Procedures

Special procedure in radiologic technology is the administering of non-routine, advanced diagnostic x-ray examinations. Radiologic technologists learn these techniques through on-the-job study, demonstration and supervised experience. There are no prescribed minimum periods of study or special registry at this time. As an example, pediatric radiography is the technique of administering radiographic procedures to pediatric patients. Many special techniques must be mastered due to the specialized problems of dealing with children. Usually, this special training is acquired through demonstration and supervised experience.

The Radiologist's Assistant

A relatively new career area still very much in the planning and development stage is the radiologist's assistant. In general, the concept of this career follows that of other physician's assistant program development. Physician's assistants are conceived as being trained to perform many of the routine duties that were to be accomplished only by the physician. The training for certification in this career will probably not be significantly longer than that for other specialty areas in radiology. The emphasis of training, however, would be in tasks such as initial interpretation of routine x-rays, ordering additional radiographic studies as indicated, management of therapy patients, etc. At this time, the extent of the duties is not complete; it is apparent that this career will not only encompass many duties of the radiologist, but also will involve technologist functions. At no time will this individual diagnose ailments in place of the physician, and the individual must function under a physician's direction. This supervision may be "over the shoulder," "on the premises" and, in some situations, "remote."

Although the foregoing comprises the bulk of the special categories for which advanced training is needed, other possibilities are not ruled out. In larger laboratories performing a large number of procedures, and sometimes utilizing exotic pieces of equipment, additional special areas of work may occur.

SPECIAL ABILITIES OF RADIOLOGIC TECHNOLOGISTS

The trained radiologic technologist is expected to be competent in the field. The special abili-

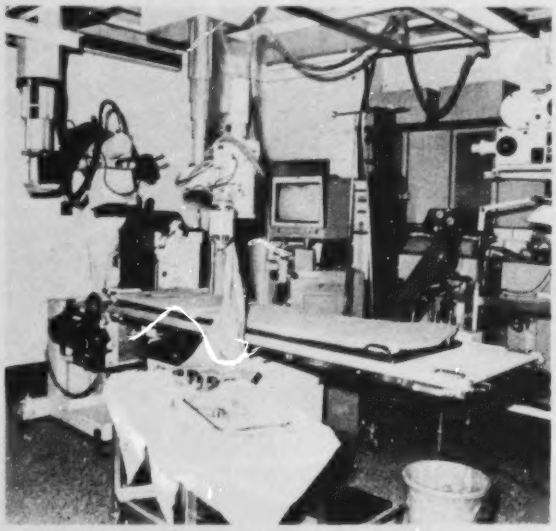

Figure 9.—Understanding the operation of complex equipment as shown above is necessary for the performance of special procedures.

ties contributing to this competence may be described by the following statements:

Technologists must have the following special abilities:

1. Background knowledge in the application of basic principles, concepts, and laws of physics and chemistry, in order to prepare the students for x-ray physics and to give them an appreciation of some of the chemical concepts involved in the study of darkroom chemistry and *opaque media*; a mastery of human anatomy and physiology to enable the students to better understand some of the biologic effects of radiation, and the knowledge necessary to enable them to intelligently interpret requisitions and position the patient for radiographic examinations.
2. Facility with mathematics to be capable of understanding how the correct *quantitative* and *qualitative radiation* factors are determined, as well as all the mathematical concepts and problems involved in x-ray physics.
3. A thorough understanding and facility in the use of radiologic equipment and materials, as well as in the procedures and methods of performing radiographic examinations, both routine and special.
4. A degree of competency and depth of understanding of the field of radiologic technology sufficient to enable the individual to establish effective rapport with fellow technologists, other *paramedical personnel*, doctors and radiologists with whom he works; the ability to perform a variety of procedures in the established and accepted manner, and the skill to exhibit individual judgement and resourcefulness in patient care.
5. Communication skills that include the ability to write and record technical information; the capability to analyze and interpret the patient's history, condition and examination requested, and the ability to transmit this information into accurate selection of *exposure factors* and examination techniques; the capacity to orally and graphically communicate with the physically and mentally ill individual in a successful manner.

ACTIVITIES PERFORMED BY RADIOLOGIC TECHNOLOGISTS

The principle portion of the radiologic technologist's work involves the proper use of x-ray and other radiation-producing equipment and material on human tissues. The principle objective of this training must be to develop the theory and skills vital to the proper and safe operation of this equipment and material.

Those courses in the educational program not specifically aimed at the development of technical skills must contribute to the foundation on which to build these skills, or supply those adjunct skills needed for the work.

In addition to the proper operation of complicated equipment, the technologist must adequately relate to and communicate with fellow workers and patients.

To build a basic science foundation the program must offer courses in mathematics, physics and biological sciences such as anatomy and physiology. Courses designed to improve communicative skills and human relations are valuable to the technologist's career.

The bulk of the course work is related to the technical aspects of this career. The approved program will offer a full range of technical courses, such as patient positioning, darkroom chemistry, special procedures, radiation safety and courses in radiation therapy and nuclear medicine.

Practicum designed to enhance the skills developed in the theoretical portion of the program must be scheduled for each student. This practicum is arranged with hospital facilities having sufficient volume and variety of procedures to offer the student a full range of practice. In order to supply this experience, the clinical facility should perform at least 6,000 procedures annually. It is felt by the

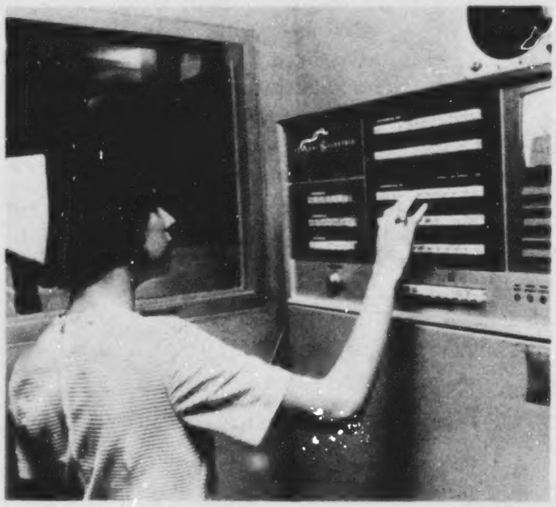

Figure 10.—Student selecting exposure factors on the control panel as an integral part of the radiographic examination.

Figure 11.—This processor illustrates how automation is a substitute for manual processing of x-ray film.

Commission on Technologist Affairs (see *Essentials of an Accredited Educational Program for Radiologic Technologists* listed in bibliography), that a clinical facility offering less than this amount does not have sufficient diversity of examinations to be able to adequately educate the student in the broad range of procedural areas.

It is essential that the clinical facility actively performs the following areas of examinations in addition to routine general radiography: complete *gastrointestinal* and *urinary tract examinations*, special procedures, radiographic procedures in surgery, radiographic bedside examinations, radiation therapy and nuclear medicine procedures. Without this diversity of examinations, a clinical facility is not able to provide the student with a sufficient variety of examinations to become a competent, experienced, graduate technologist.

PROGRAM PLANNING

Most programs offer the minimum acceptable length of training, which is 24 months. Educational institutions operating or developing educational programs of this length may wish to weigh the relative merits of terminal or career curriculum against the desirability of a program for transfer toward an advanced degree. Community colleges in particular will discover that much of the career program is also a transfer program. Development of the curriculum in cooperation with the baccalaureate institution will promote optimum transfer potential. In those areas where it is not feasible to effectively accomplish both objectives, the educational institution should adhere to its philosophy of education. It should be noted that the graduate of the accredited two-year program is fully eligible to be a registered radiologic technologist and to fully practice the techniques of this discipline. In most cases it would appear unwise to sacrifice the career potential to promote transferability.

An educational institution offering multiple curricula in the health technologies may discover that certain courses, particularly in the basic sciences, can be structured to effectively serve more than one program. The development of this type of core curriculum can effectively reduce costs and promote the efficiency of the program.

PROGRAM EVALUATION

An educational administrator might desire to evaluate the likelihood of implementing an educational program in radiologic technology in his institution. The following steps in program evaluation are included as an aid:

1. Define the scope of the technical program: A preliminary step designed to acquaint school administration with community resources and identify key people to be used as consultants.
2. Become aware of the operative systems of standards in the health field:

Figure 12.—Unless a patient is accurately positioned for a radiographic examination, a diagnosis cannot be obtained. Here, a radiologic technologist is correctly positioning the patient's hand, utilizing all necessary protective measures.

  - a. Legal regulation based on state statutes
  - b. Voluntary registries or certifying boards
  - c. Voluntary system of approval of educational institutions for the conducting of programs
  - d. Voluntary system for approval of health care facilities for the conducting of programs

3. Review the educational institution's objectives and the impact of adding a health technology program:
   - a. Added facility and faculty needs
   - b. Additional problems of technical programs
   - c. School strengths and weaknesses for these types of programs

Decision point—Interest or lack of interest in developing a health technology program.

4. Survey of community of need for health technology programs:
   - a. National manpower needs
   - b. Local manpower needs
   - c. Whether local needs follow national trends
   - d. Probability that needs will persist
5. Evaluate feasibility of program development:
   - a. Availability of adequate clinical facilities
   - b. Probability of meeting quality criteria
   - c. Availability of qualified director and technical faculty
   - d. Availability of career opportunities such that students will be attracted to the program
   - e. Availability of students
   - f. Adequacy of school's financial resources to fulfill the financial requirements of the program
   - g. Adequacy of school to meet added demands on physical plant, library, personnel services, and so forth
   - h. Possible superiority of multiple health technology programs

Decision point—Selection of program(s) to be implemented.

6. Secure program resources:
   - a. Faculty procurement
   - b. Facilities for clinical experience
   - c. Facilities for on-campus laboratory
   - d. Objectives and projected curriculum
7. Curriculum development

Decision point—Beginning date of program(s).

Follow-up—Maintain check on program to evaluate for needed changes in curriculum, including clinical phase.

ACCREDITATION

As the program planning takes definite form, the sponsoring institution (see Appendix F) should consider steps toward accrediation (see Appendix E). Although full approval will not be granted until the program is operational, the institution should make the initial contact once the curriculum is formed, clinical facilities arranged, and the program director identified. It is entirely possible that the accrediting organization can offer constructive criticism of the various facets of the program at this point. In addition, this early contact will alert the accrediting body to the institution's intentions, and the completing of the application serves as a self-evaluation of the intended program in terms of the approval criteria.

Requests for application forms should be directed to the Assistant Director, Department of Allied Medical Professions and Services, American Medical Association (see Appendix D). Once the application is complete, two copies are returned to the Assistant Director. This material is forwarded to the Joint Review Committee on Education in Radiologic Technology for review and recommendation. A favorable recommendation usually results in initial approval status, pending an on-site visit by a survey team (see Appendix G).

Upon completion of the site-visit evaluation, the survey team's findings are reviewed by the Joint Review Committee. Their recommendations are forwarded to the A.M.A. Council on Medical Education through its Advisory Committee on Education for the Allied Health Professions and Services. The council on Medical Education reviews the recommendations and grants approval to qualified programs. Action taken by the Council is transmitted to the program director with specific recommendations, if any, for improvement of the program.

It is advisable to request the *Essentials of an Accredited Educational Program for Radiologic Technologists* from the A.M.A. Department of Allied Medical Professions and Services. In this way the program planner is assured of having the most recent criteria for accredited programs.

Since this accreditation is a voluntary procedure, the question of its importance to the sponsoring institution and the student occasionally arises. Although the procedure is voluntary, it is the only standard of quality having national significance. Since no other standard exists nationally, employers usually seek only the registered technologist for employment. One of the criteria for an individual's recognition by the American Registry of Radiologic Technologists is graduation from an A.M.A.-approved program. Therefore, school accreditation is vitally important.

Some states have established licensure for Radiologic Technologists. In some instances, the state licensure is based on minimal standards rather than optimum standards. In states having licensure, the technologist must adhere to these requirements. However, licensure should not be considered a substitute for registry. Licensure by an individual state may not be an acceptable standard for another state and, even within the licensing state, the employer may show employment preference to the technologist who also achieves registry. Sponsoring institutions are advised to check the status of licensure in their state.

FACULTY

The recruitment of faculty for the new program is never an easy task. Minimum faculty requirements for the program are:

1. The program must be under the direction of a licensed physician who shall be certified, or eligible for certification by the American Board of Radiology. While this medical director need not be full time at the program, he must be actively interested and in attendance sufficient time to adequately supervise the educational program.
2. There must be at least one instructor who is a trained radiologic technologist, registered or eligible for registry by the American Registry of Radiologic Technologists.
3. In addition, there must be well-trained technologists capable of assisting in classroom instruction as well as in the practical teaching of students.
4. The recommended ratio of technical instructors to students should be one registered technologist to every three students. This ratio is particularly recommended for the practicum phase of the training; larger ratios may be acceptable in the didactic presentation of theory.

The above standards are intended for the career or technical courses of the program. In the area of general education and preparatory science, the school may use the normal teacher-student ratios.

It is advisable to exceed the preceding minimum faculty qualifications whenever possible. Additional formal education and experience, particularly in education, is strongly recommended.

Since some states require teacher certification, it is advisable to contact the State Department of Education for regulations regarding the certification of faculty in the health fields. However, technical instructors in educational institutions should assume the same responsibilities and privileges afforded other faculty members, and it behooves the educational institution to orient the technical instructional staff in the same manner as other faculty. They should be made aware of the philosophy of the educational institution, just as the educational institution should be made aware of the philosophy of the clinical facility, as well as that of the technical staff of the hospital and the instructional staff of the educational institution in educating the students.

STUDENT SELECTION AND SERVICES

Although every attempt should be made to admit those prospective students who are interested in the radiologic technology program, the goals of these students must be realistic. The student whose academic background and potential is below the desirable entry standard should not be allowed admission to the program. On the other hand, the person who possesses an intelligence level and potential that far exceeds the necessary qualifications will probably experience boredom and disillusionment. The entering student must possess qualifications which match the goals of the program.

The quality level of course material must not be lowered, or failure of the program will eventually result. Although most community colleges have an open-door policy, definite criteria should be set down and consistently adhered to in the acceptance of students into the career programs.

In radiologic technology, the prerequisites for national certification with the American Registry of Radiologic Technologists must include graduation from high school or its equivalent, with recommendations of completion of mathematics (including algebra and geometry), physics, chemistry, and biology.

If a student does not have the necessary prerequisites, he should be counseled into a remedial program to prepare him for entry into the program. The remedial program should be available for applicants who do not have the necessary language skills, mathematics, or science preparation. The student who acquires the necessary requisites through remediation will have afforded himself and the educational institution a reasonable opportunity for a success as a student technologist.

It is necessary that the college have a good counseling and guidance program. It may be necessary to assist a student to make an intelligent change of objective and to guide the able student with special interests into a career objective where he can and will succeed, and where his services are badly needed by the community. This provides a distinct and important service to both the student and the community.

Adequate staff and funds to provide necessary recruiting activities and related services must be provided by the administration of the institution. Recruiting involves some publicity, if no more than the publication of a brochure of the program. The minimum requirement of such published information is that it be a complete, clear, and factual description of the program.

There should be an orderly procedure, consistently followed, for applying for admission to the institution and program. Testing of the student, by the institution or by a state or local agency for his probable scholastic success as a student technologist, is becoming more common.

It is essential that adequate records be maintained to assist the student during and after admission, and subsequent to graduation. Other than the usual academic records, it is imperative that an accurate record of the student's experience in the clinical facility be maintained by both the college and the affiliating hospital. This should include the hours the student spends at the hospital as well as a breakdown of the student's activities, specifying examinations he has performed both with and without supervision or technical assistance.

Assistance and information concerning scholarships, loans, and grants of aid should be published and made available to students. Students should be made aware of the conditions under which such aid is available and awarded, and the obligations of recipients. The procedure to follow to apply for such aid should be clearly stated.

Students should be given information concerning student membership in professional organizations on local, state, and national levels, and they should be encouraged to join such societies.

LIBRARY FACILITIES AND CONTENT

The growth and success of graduate radiologic technologists will depend to a great extent on their ability to keep abreast of the changes in equipment and procedures in radiologic technology. They must, therefore, have gained experience in using a library. The library should be centrally located and readily accessible to students and faculty.

Facilities, content, organization, and services for programs to educate technologists must be adequate to meet the special requirements of the staff and the students in the program. The library must contain at least a minimum of the scientific and technical books, references, periodicals, and journals of scientific and technical societies.

The library must adequately provide materials containing the knowledge encompassed by all subjects in the curriculum and extend somewhat beyond the degree of complexity or depth encountered in classroom activities. Literature dealing with unusually highly-specialized aspects of the subject may be acquired as needed, or may be borrowed by the librarian from more comprehensive libraries.

LABORATORY EQUIPMENT AND FACILITIES

Normal environmental control for most technology laboratories and classrooms is necessary, and in geographic areas where extremes of warm weather and high humidity prevail for any appreciable part of the year when the facilities are to be used, air conditioning has been found to be almost necessary.

Classrooms near the laboratories are usually desirable. Classrooms and laboratories should be well lighted with a recommended minimum of 50-foot candles of light at the table or desk tops. Fluorescent lighting is usually satisfactory.

Laboratories and equipment for teaching technology programs must meet high standards of quality since the objectives and the strength of the programs lie in providing valid laboratory experience, basic in nature, broad in variety, and intensive in practical experience.

Well-equipped laboratories with sufficient facilities for all students to perform the laboratory work are required for their specialized courses. The training program should include experiences which illustrate the function and application of principles using as wide a variety of components, devices, units, systems, procedures, techniques, and services as is practicable and consistent with what may be encountered by the technologist when he is employed.

Variety and quality equipment and facilities are more important than quantity in equipment laboratories. Laboratory equipment and facilities are a

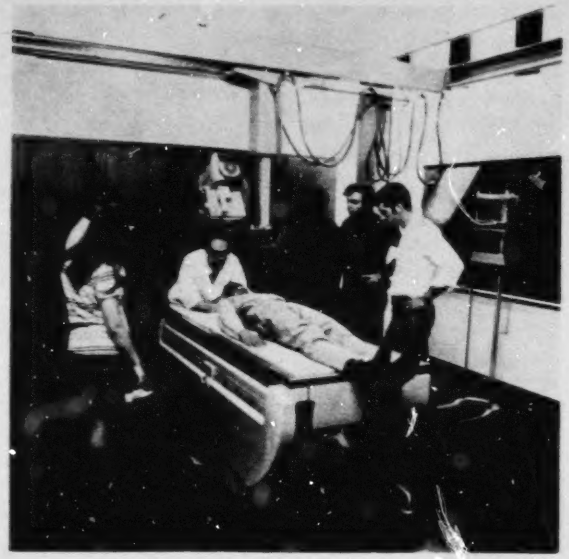

Figure 13.—The student can obtain valuable educational experience in on-campus laboratories. Here the instructor is demonstrating proper radiographic techniques to a class of students.

major element of the cost of such a program, and they are indispensable if the training objectives are to be met.

Equipment and apparatus must be of good quality if laboratory work is to supply valid experiences for the student. Inferior equipment may not show the principles being studied or may not be sensitive enough to provide reliable or precise data or experience, and may require unreasonable amounts of time and expense to keep them repaired or adjusted to usable condition. It is recognized that the initial cost of high quality equipment is usually greater than that of low quality, but the difference in cost is justifiable because it makes possible laboratory experiments that give precise results and experience which is valid in employment situations. The laboratory equipment must conform to all safety standards. These are outlined in NCRP Handbooks No. 33 and 34 (see bibliography).

Equipment for the specialized laboratories for any technical program should be selected by the technical specialists who head the program and teach it. When specifying and selecting laboratory equipment, the need for each item should be well established. Expensive apparatus may not always be required. Many significant experiments and experiences can be performed and learned with relatively inexpensive components. In fact, they can, in many cases, make the principles more evident because they present only the essentials. The number of units purchased, the particular areas of interest, the emphasis of a particular industry, and the ingenuity of the instructor(s) in adapting apparatus to teaching needs will play a major part in governing the cost and selection of laboratory equipment. Throughout the program, the emphasis should be on the basic underlying principles which serve as the basis for the applications in the specialized field of science, and on developing understanding as well as skillful performance of the techniques, procedures, measurements, determinations, and services that identify and are peculiar to that particular technology.

Demonstrators and simulators for teaching various concepts, processes, principles, devices, and interrelations in systems are available for teaching many specialized technical subjects. In setting up a laboratory, however, the planners of the teaching program and laboratory equipment should make a thorough study of all the simulation, demonstration, and teaching systems available at the time. There is an increasing number of manufacturers of these units. The pertinence, excellence, and effectiveness of their products provide a means of placing pre-assembled equipment systems in the laboratory, usually designed specifically as a teaching unit, thus saving considerable time and effort for the instructor who otherwise would have to build or assemble these systems for the laboratory.

When using demonstration or simulation equipment to teach principles, it is essential that real apparatus, typical of that used in employment situations, be used so the student may complete the learning experience. The student must see and understand radiographic principles as applied in the use of standard apparatus, and learn to be able to manage and use this apparatus with technical skill and competence.

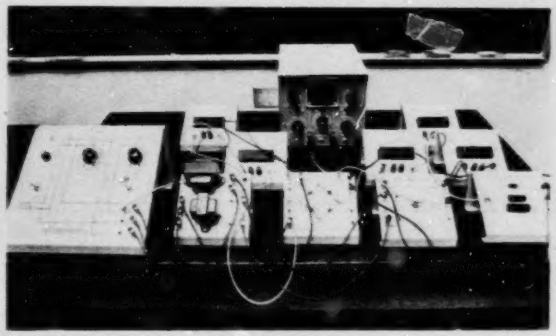

Figure 14.—Specialized laboratory apparatus, such as this x-ray simulator, can be a valuable adjunct to instruction in x-ray physics.

Surplus equipment from either private or public organizations can be an important source of good materials and hardware for equipping technical laboratories.

ADVISORY COMMITTEE

Once a decision has been made to consider a program in radiologic technology and prior to any specific planning, the school should select an advisory committee (see bibliography, *The Role of the Advisory Committee in Occupational Education*). This should be a working committee; therefore, the number of members should be sufficiently few to promote productive discussion and form reasonable decisions. The committee should be composed of radiologists and radiologic technologists with practical experience within the target area to be served by the program. Physicians and technologists who have had experience with educational programs are preferred. A hospital administrator, as well as a lay consumer representative, should also be included in the general make-up of the advisory committee. The educational institution's administration should be represented, and the coordinator of the radiologic technology program should serve this committee in a non-voting capacity.

The committee and the individuals serving should be duly recognized by the educational institution's administration as cognizance of their importance to the program. Provisions must be made for expansion and replacement as needed. The committee should be self-governing.

Representatives of suppliers, although sometimes quite knowledgeable, should not be members of the committee, but should be used as consultants for equipment and supply specifications. The advisory committee may reasonably be expected to take a very active role in the planning and supply information relative to the following:

1. Subject matter to be covered in the technical courses
2. Employment opportunities and job opportunities
3. Relationships with registries or other accrediting organizations in the respective field
4. Student recruitment and selection criteria
5. Technical faculty qualifications and availability
6. Identification and availability of needed clinical facilities
7. Identification and solution of potential problems
8. Continuing evaluation of the program

The advisory committee should give their critique of all segments of the planning, including tentative curricula. They should have the right of final approval jointly with the educational institution's academic approval body. The advisory committee structure should be continued after the curriculum is approved. Their role now becomes one of assisting in student and faculty recruitment, identifying clinical facilities and assisting in relationships with these facilities, and accrediting organizations. The committee can also be helpful in identifying equipment for specialized laboratory facilities.

THE CURRICULUM

Functional competence in a field such as radiologic technology has at least three components around which a curriculum must be designed:

1. Successful completion of the curriculum should prepare the graduate to be a productive employee in a job at the entry level.
2. The broad technical curriculum, together with a reasonable amount of practical experience, should enable the graduate to advance to positions of increasing responsibility.
3. The foundations provided by the curriculum must be broad enough that the graduate can do further study within the field. This further study may deal with current advances and improvements within the field, or formal course work leading to upward mobility within the field.

It is the responsibility of the educational institution to provide the student with sufficient and meaningful clinical experience under appropriate supervision in order to meet national requirements.

The curriculum should contain the capability of substituting college transfer courses for terminal or non-transfer courses. As an example, if a student enters a program of study with the intention of entering a baccalaureate program later, or even if that student has the ability to do well in a transfer course rather than in a terminal course, such as college algebra rather than technical mathematics, the student should be counseled into the transfer course. This transfer capability should be available to every student who desires, and who is competent to take, those transfer courses that will enable the student to continue an education toward the baccalaureate level.

In some states, the curriculum could be partially determined by state requirements. Certain academic courses required for graduation will have to be included in the curriculum for schools of radiologic technology in these states.

This suggested curriculum is organized as 17-week college semesters rather than as college quarters because it is usually easier to convert a program from semesters to quarters.

The curriculum and course outlines show a 16-week semester schedule. It will be noted that no examinations are scheduled in the course outlines which follow later. It is intended that the additional week be used for examinations. In this curriculum, 2 hours of outside study time are suggested for each hour of scheduled class time.

It must be stressed that this is only a model guide; it must be tailored to the needs of the individual institution. Innovations by the instructor should be encouraged.

It should also be noted that in this guide, the educational institution awards college credit for only partial fulfillment of certification requirements (see Appendix A). It must be made perfectly clear to the prospective students that they will not complete the curriculum until they have satisfied all practicum requirements.

CURRICULUM OUTLINE FOR RADIOLOGIC TECHNOLOGY

FIRST SEMESTER

	HOURS PER WEEK			
	Class Hours	*Laboratory Hours*	*Outside Study*	*Total Hours*
Physical Science I	2	2	4	8
Technical Mathematics I	3	0	6	9
Human Anatomy and Physiology I	2	2	4	8
Darkroom Chemistry and Technique	1	0	2	3
Patient Care and Ethics Pertinent to Radiology	1	0	2	3
Radiologic Technology I	3	6	6	15
Clinical Experience I	0	6[1]	0	6
	12	16	24	52

Clock Hours

[1] In Hospital: 16 weeks @ 6 hours per week = 96

SECOND SEMESTER

	HOURS PER WEEK			
	Class Hours	*Laboratory Hours*	*Outside Study*	*Total Hours*
Communication Skills I	3	0	6	9
Human Anatomy and Physiology II	2	2	4	8
X-ray Physics	3	0	6	9
Radiologic Technology II	3	6	6	15
Clinical Experience II	0	12[1]	0	12
	11	20	22	53

Clock Hours

[1] In hospital: 16 weeks @ 12 hours per week = 192
Summer: 10 weeks @ 40 hours per week = 400
1st sem.: 16 weeks @ 6 hours per week = 96

Total at end of summer = 688

THIRD SEMESTER

	HOURS PER WEEK			
	Class Hours	*Laboratory Hours*	*Outside Study*	*Total Hours*
Communication Skills II	3	0	6	9
Human Relations	3	0	6	9
Elective[1]	3	0	6	9
Radiologic Pathology	2	0	4	6
Radiologic Technology III	3	0	6	9
Clinical Experience III	0	18[2]	0	18
	14	18	28	60

[1] Elective may be used to meet state or institutional requirements.

Clock Hours

[2] In hospital: 16 weeks @ 18 hours per week = 288

Total hours at end of summer = 688

Total hours at end of third semester = 976

FOURTH SEMESTER

	HOURS PER WEEK			
	Class Hours	*Laboratory Hours*	*Outside Study*	*Total Hours*
Business Organization and Management	3	0	6	9
General Psychology I	3	0	6	9
Radiation Therapy, Radiobiology and Nuclear Medicine Technology	3	0	6	9
Radiologic Technology IV	3	0	6	9
Clinical Experience IV	0	18[1]	0	18
	12	18	24	54

Clock Hours

[1] In hospital: 16 weeks @ 18 hours per week = 288

A 6-month internship following completion of curriculum:

24 weeks @ 40 hours per week = 960

Total hours at end of third semester = 976

Total hours at end of internship = 2224

BRIEF DESCRIPTIONS OF COURSES FOR THE RADIOLOGIC TECHNOLOGY PROGRAM

First Semester

Physical Science I: This course provides an introduction to science and includes a study of magnetism, electricity, and chemistry applied to technology. This course also offers a descriptive introduction to technical applications of atomic and nuclear physics.

Technical Mathematics I: Course content includes standard notation and use of slide rule, including multiplication, division, powers, roots. The course also includes operation of algebraic expressions and fractions, manipulation of physical units, algebraic solution to linear equations in one unknown, cartesian coordinate plane, slope of a straight line, determining linear equations from given conditions, and graphical solution of two or more linear equations.

Human Anatomy and Physiology I: Course content includes a study of the structure and function of the human skeletal, muscular, nervous, and circulatory systems.

Darkroom Chemistry and Technique: This course covers the principles of darkroom procedures. Manual as well as automatic methods of processing x-ray film are taught, including the chemistry of each method.

Patient Care and Ethics Pertinent to Radiology: This course serves to introduce the student to the various ethical considerations and patient care pertinent to the radiologic technologist. The student will practice such techniques as obtaining vital signs, proper syringe technique, and first-aid measures.

Radiologic Technology I: In this course, radiography of the appendicular skeletal system, ribs, sternum and sternoclavicular joints is presented. The student is instructed in every phase of radiologic technology in an integrated coverage of each of the above areas.

Clinical Experience I: In this course the student gets practical experience in processing of radiographs. Departmental and medical terminology is applied as well as ethical and attitudinal situations in his initial patient contact. The student observes all areas of departmental procedures as well as interdepartmental activities and relationships. Basic patient positioning of the upper and lower extremities to include the shoulder and pelvic girdle as well as the application of the more simple exposure principles are also included.

Second Semester

Communication Skills I: Course content includes a study and analysis of fundamental writing, oral and listening communication skills, with emphasis on and evaluation of communication techniques used in areas of mass communications media, such as newspapers, magazines, films and television.

Human Anatomy and Physiology II: Course content includes a structural and functional approach to the digestive, respiratory, excretory, endocrine, and reproductive systems, and a survey of the embryology of the major body systems.

X-ray Physics: This course is a study of the fundamentals of magnetism, electricity, and radiation physics. The student is given a basic understanding of the principles of x-ray production and their interaction with matter.

Radiologic Technology II: This course is a continuation of Radiologic Technology I. The student will be instructed on every phase of radiography of the axial skeleton, thoracic viscera, abdomen, digestive system, urinary system, and dental radiography.

Clinical Experience II: The student performs those examinations requiring the use of contrast media: the digestive tract, biliary tract, and urinary tract. The vertebral column, skull and contents, dentals, chest, and other general radiographic procedures are also included in this clinical experience.

Third Semester

Communication Skills II: This is a continuation of Communication Skills I in which communication skills are studied primarily from the practical aspects. The course emphasizes exercises in speaking and listening.

Human Relations: This course is designed as an introduction to the basic principles of sociology, general psychology and industrial psychology. Major emphasis is placed on such topics as the origin and development of the social body, group behavior, and the problems attendant to leadership and cooperation. It is designed to develop a thorough understanding of good human relationships in the industrial complex. The course also proposes to aid in the formation of sound citizenship.

Radiologic Pathology: This course is designed to acquaint the student with certain changes which occur in disease and injury and their application to radiologic technology.

Radiologic Technology III: This course is a study of specialized and highly technical procedures carried out in the department of radiology. Included in this course is a study of the special equipment, opaque media, and radiographic anatomy involved in the procedures.

Clinical Experience III: The clinical experience is concentrated in special procedures, including the use of specialized equipment. Additionally, the student is supervised in radiography during surgical procedures in the operating room as well as in radiographic bedside examinations.

Fourth Semester

Business Organization and Management: This course is a study of basic concepts, functions, and the management process of planning, organization, staffing, direction, and control as they relate to modern business operations and problems.

General Psychology I: This course is a bio-social scientific study of physiological, mental, and emotional development of normal human behavior. It includes a short history of modern psychology as well as introductory statistical concepts and is a prerequisite for all other courses in psychology.

Radiation Therapy, Radiobiology and Nuclear Medicine Technology: This course emphasizes the use of x-rays and other ionizing sources in the use of therapy as well as the fundamentals of radioisotope technology and the role of the technologist in their use. The absorption of radiation, its effect upon tissue and tissue recovery is also studied.

Radiologic Technology IV: This course is a study of pediatric radiography, radiologic records, and various principles of teaching in schools of radiologic technology. The last few weeks of this course are devoted to comprehensive review.

Clinical Experience IV: Limited clinical experience is obtained in the radiation therapy and nuclear medicine departments. The student gains experience in the art of pediatric radiography during this semester. This course also serves as a continuation of clinical experiences in all phases of radiologic technology, perfecting the techniques and procedures previously experienced.

CURRICULUM CONTENT AND RELATIONSHIPS

The curriculum content and organization are influenced by the special occupational needs of the graduates, the limited time available to teach the curriculum, the accreditation standards, and the new techniques which seem imminent in the field of radiologic technology.

Great care has been exercised in selecting and arranging the subject matter in this curriculum. It is assumed that some transfer of knowledge will take place to prepare the student to meet new situations as they may arise. It is not possible to include all of the science and mathematics which might be found in a 4-year program, so concepts which are most important to radiologic technology are stressed. For this reason, the sequence of courses shown in the curriculum is important.

The relationship between laboratory time and class lecture time is of great importance in this curriculum. The factual information which is presented in the didactic portion of the program can and must be illustrated by demonstration in the laboratory. The laboratory sections must be sufficiently small to allow each student ample opportunity to practice the procedures on a radiographic phantom. It must be emphasized that under no circumstances should x-ray exposure be given to a student or any other human being unless it is used in a diagnostic study under the direct supervision of a radiologist.

Much valuable experience, however, can be gained by the student in practicing positioning, properly exposing film and processing the film in the on-campus facility. In this way, although the conditions in the laboratory radiographic examination differ from those in the hospital, the student technologist will be better equipped to transfer the knowledge from phantom radiography to patient radiography.

Radiation safety measures, both to patients and personnel, are stressed throughout the course of study. There are radiation, electrical, and mechanical potential dangers involved in a technologist's work. By learning to use careful procedures, such as shielding and exact collimation of the x-ray beams, and by observing normal safety practices, many dangers can be avoided. The importance of protecting human life is paramount, but students must also learn good work habits and develop a pride in workmanship. In the hospital, the technologist will be working with expensive equipment. A mistake in calibrating the technical factors to be used in radiography, depending upon the seriousness of the error, can result in loss of time, money, or even life. Teaching proper care of expensive equipment is more important than having to repair it as a result of negligence.

In technical curriculums it is mandatory that specialized technical course work be introduced in the first semester. Deferring this introduction even for one term imposes serious limitations on the effectiveness of the total curriculum. Two of the important advantages that occur from an early introduction of the technical specialty follow:

1. The student who enrolled in school to study radiologic technology starts training immediately in this specialty. If the first semester consists entirely of general subjects—mathematics, English, social studies—the student might lose interest.
2. By introducing the technical specialty in the first semester it is possible to achieve greater depth of understanding in specialized subjects during the later stages of the 2-year program.

It is felt that the above advantages also apply to practical experience being performed in the hospital. From the beginning of the first semester throughout the curriculum, practicum should be coordinated with the technical courses.

Radiologic technology is a profession in which the technologist must be able to communicate with patients, his peers and all those in the allied health fields. The technologist is a very important member of the health-care team and is also directly responsible for the patient in the radiology department. For this reason, courses in communication skills, human relations and psychology are felt to be of utmost importance. Anatomy and physiology, although it can and should be stressed in the technical courses, is a necessary and valuable course offered to the student in radiologic technology.

X-ray physics and darkroom chemistry are essential courses in the radiologic technology curriculum and it is felt that a basic background in general physics and chemistry should be offered the student as a preparation for these courses; thus, physical science is recommended.

The integrated approach for the radiologic technology courses suggested in the outline should be scrutinized in detail. A cursory investigation of the outline might suggest that such important subjects as radiation protection, medical terminology, and principles of radiographic exposure are only superficially included. Or it might be inferred that the minimum clock-hours recommendation in the basic curriculum endorsed by the American Society of Radiologic Technologists (see bibliography, *Curriculum and Teacher's Syllabus for Schools of Radiologic Technology—A Teaching Guide*), is not followed. Critical investigation, however, will indicate that a great deal of time is allotted to all of these subjects in a concatenated manner. Each of these smaller units are added together in each section of Radiologic Technology I and II with a cumulative effect. These subjects are explained and reiterated numerous times throughout the curriculum.

Summer working experience in the hospital is recommended between the first and second years of study. This should be a mandatory requirement both for continuity in the learning process and also as a means of fulfilling accreditation requirements.

COORDINATION WITH CLINICAL FACILITIES

Since the educational institution must form affiliation with radiology departments located in medical service facilities to accomplish the practicum, the instructional relationships between the two institutions must be considered.

Ideally, control of the students should be under the full-time college technical staff. From a practical point of view, it is not always feasible to assign college staff to the service facilities for the entire time the students are in the practicum phase. However, it is possible for the college staff to coordinate and guide these activities through frequent visits and discussion with the staff and students at the service facility. The coordinator from the educational institution should make an effort to involve the technical staff from the hospitals in all phases of curriculum development, and provide in-service education for the technologists, where indicated.

It should be made clear that the students are the responsibility of the educational institution, and any activity affecting the educational program will be coordinated with the school. This coordination can be promoted through careful selection of those technologists within the service facility accepting responsibilities for the training activity. These persons should be recognized through the granting of part-time faculty status.

To the greatest possible extent, practicum should be scheduled to complement the theory being taught. Every effort should be made to avoid student assignments having little or no educational value. Included in this category are housekeeping chores, repetitive filing and other non-technical routines which may be largely unsupervised. The question of students taking night call, weekend, and holiday assignments, must be decided on the basis of educational value. This can be a valuable learning experience if a technologist is assigned to work with the student to provide supervision and instruction as needed. Procedures performed during these periods are largely emergency and unscheduled and are usually more complex than scheduled procedures. It is recommended that a minimum of this type of assignment be scheduled for educational purposes. It is conceivable that some students can adequately handle such assignments on an extra-curricular basis without harm to their basic education.

As with any educational activity, records must be kept of each student's progress through the prescribed curriculum. In the case of the radiologic technology student these will include not only traditional records of his growth in the didactic portions of the program, but also adequate records of time, types and numbers of procedures performed and other experiences gained during the clinical practicum phases of the curriculum.

In some areas with few hospitals, the educational institution may not have a great deal of choice in the selection of clinical facilities for the program. Basically, the selected facility must be able to comply with the requirements stated in the *Essentials of an Accredited Educational Program for Radiologic Technologists* (see bibliography) for an approved program. In addition to these basic requirements, the educational institution should ascertain that the service facilities staff is sincerely interested in the educational program.

Affiliation between educational institutions need not be a binding legal contract; however, written agreement is strongly recommended (see Appendix B). The existence of a written agreement is evidence to the accrediting body that both parties have serious interest. The agreement should outline the responsibilities both parties have to the student, what items of personal equipment, such as film badges, each will supply, and whatever other items of agreement will result from mutual discussion. Local and state laws relating to liability and malpractice may vary. These statutes should be determined and properly recognized. Student stipends, if any, should be agreed upon and included. It is recommended that all grading and student discipline be coordinated through the college. Exceptions may be made in the area of discipline for cases which threaten personal or patient safety or for detrimental behavior which may necessitate immediate action. In instances where more than one clinical facility is involved, it is important that the individual agreements be similar in all major details.

SUGGESTED CONTINUING STUDY

This curriculum, as outlined, is not intended to make the students proficient in all duties they may be asked to perform. Proficiency comes only with experience, practice, and further study of specialized problems that may arise on the job. It is also impossible to predict changes that may arise due to our changing economy and technology. Some form of continuation of study for graduates of technology programs is therefore mandatory.

By reading current literature related to the technology, the student can keep abreast of technical developments of this special field, but this tends only to build on the organized technological base provided by the curriculum he studied.

Continuation of the educational process provides the most efficient and practical means for the graduate technologist to add important related areas of knowledge and skill to his initial education.

The educational institution should consider assisting the graduates of the radiologic technology programs by offering supplementary courses in the Continuing Education division. Some suggestions for additional study would include management courses, technical writing, parliamentary procedure, new specialized procedures, and innovations and changes in equipment.

Besides offering continuing study for graduates of the program, the educational institution should also provide the opportunity to veterans and graduate technologists from hospital-based programs to earn an associate degree. Tests should be designed so the technologist may challenge the technical and general education courses and receive credit by evaluation. Other general education courses could then be taken at night to meet degree requirements.

COURSE OUTLINES

The courses which follow are intended to suggest the content which might be taught in the curriculum. The materials suggested provide a practical and attainable coverage of the field and have been reviewed by experienced instructors in successful educational programs of radiologic technology and by experts representing employers of such graduates.

It is expected that these materials will be modified in some measure to fill the needs defined by local advisory committees and to take advantage of special interests and capabilities of the teaching staff in any particular institution; but the implied level, quality, and completeness of the program should not be compromised.

At the end of each course is a list of text and reference material. Each list should be analyzed for its content and pertinency; new and more suitable ones should be substituted if they are available. The information needed to cover a particular course in technician educating curriculums, particularly the technical specialty courses, is almost never available in one textbook, hence the multiple listing of references. They usually should be augmented by the current materials from manufacturers, trade journals, technical societies, and suppliers of apparatus and services in the special field of applied science being studied.

Suggested visual aids are listed for many courses. Each should be used when pertinent and when its use will teach more efficiently than any other method. Excessive showing of films at the expense of well-prepared lectures and demonstrations is to be avoided. The suggested outside study periods may well be used instead of class lecture time for the showing of some films. All visual aids should be examined by the instructor before they are shown. Those listed after courses show the necessary information for selection and showing of films.

It is expected that the experienced instructor will make liberal use of charts, slides, models, and samples which illustrate special technical aspects of the subject. These aids are usually accumulated from the experience of previous laboratory or lecture preparations of the instructor, and should be updated regularly when new developments require it. They are too specific for any attempt to be made to list them in this suggested guide.

The clinical experience has been included in this curriculum outline. It is suggested that every effort should be made to provide concurrent clinical experience with the technical courses. It must be determined by the individual school whether to offer academic credit for clinical experience. For example, one credit hour can be given for six practicum hours each week for a 16-week semester.

The laboratory sessions suggested in the curriculum outline and course descriptions are not necessarily intended to be a single session, but rather as total hours of laboratory per week, to be scheduled in reasonable and effective increments. For example, a 6-hour laboratory total per week for a course might be scheduled as three 2-hour sessions or two 3-hour sessions, or any other divisions of laboratory time that seem appropriate.

TECHNICAL SPECIALTY COURSES

Clinical Experience I

HOURS PER WEEK

Practicum, 6

Course Description

This course enables the student to become oriented to the hospital and the department of radiology. Time is also allotted the student to observe procedures, first under direct supervision, and finally, unaided. Because of the number of students assigned to the hospital, it is not always feasible to coordinate clinical and didactic material, although every effort should be made to assure the student of the opportunity to gain the desired proficiency in those examinations which are being stressed at the college. At the end of the first semester, the student should achieve the following results:

- A. General acceptance of the field of radiologic technology
  - 1. Should demonstrate their interest as members of the health care team
  - 2. Should display an attitude conducive to proper interrelationships
  - 3. Should manifest a desire to promote high standards of ethical and moral conduct
- B. Technical proficiency in selected procedures
  - 1. Should have the ability to adequately position upper and lower extremities to include shoulder and pelvic girdles
  - 2. Should be capable of efficiently carrying out all of the phases of darkroom technique
  - 3. Should have a rudimentary proficiency in the use of departmental and medical terminology
  - 4. Should have the adeptness to utilize elementary exposure principles
  - 5. Should exhibit competence in applying the principles of radiation protection

Major Divisions

	Practicum Hours
I. Orientation to the Radiology Department	6
II. Orientation to the Hospital	6
III. Observation in the Radiology Department	24
IV. Practicum with Supervision	60
Total	96

Units of Instruction

- I. Orientation to the Radiology Department
  - A. Tour of the radiology department
  - B. Introduction of department personnel
    - 1. Radiologist(s)
    - 2. Supervisor(s)
    - 3. Technologist(s)
    - 4. Auxiliary personnel
  - C. Mutual expectations
    - 1. Departmental
      - a. Rules and regulations of department
        - (1) Hours
        - (2) Attire
        - (3) Conduct and attitude
      - b. Agreements with the educational institution
    - 2. Student
      - a. Proper supervision
      - b. Educational value of practical experience
- II. Orientation to the Hospital
  - A. Tour of physical facilities
    - 1. Diagnostic, therapeutic, and ancillary departments
    - 2. Nursing divisions
    - 3. Administrative and business areas
  - B. Essential information
    - 1. Hospital philosophy
    - 2. Regulations and restrictions
    - 3. Overview of interdepartmental relationships
  - C. Observation in selected departments
    - 1. Emergency
    - 2. Surgery
    - 3. Laboratory
    - 4. Physical therapy
    - 5. Inhalation therapy
    - 6. With radiology department transporters
- III. Observation in the Radiology Department
  - A. Cursory survey of departmental facilities
  - B. Observation of specific procedures
    - 1. Chosen for educational value
      - a. Explanation of procedure by instructor

b. Coordination of practicum and didactic
2. Mechanics of observation
a. Number of students observing examination
b. Student deportment or manner
c. Patient's acceptance of student
IV. Practicum with Supervision
A. Progression from student assistance to eventual supervised practicum
1. Student assists in elementary tasks
2. Instructor, gradually and under control, increases student responsibility
B. Observation of student activities by the instructor
1. Student performance of procedure primarily unaided
2. Close observation of student performance by instructor
a. Instructor gives assistance when necessary
b. Corrections made without patient's knowledge
C. Procedure done by student with instructor's assistance readily available
1. Student should have assurance of availability of instructor
2. Student must perform procedures unaided and repeatedly in order to gain proficiency and self-confidence

Clinical Experience II

HOURS PER WEEK

Practicum, 12

Course Description

This practicum course is a continuation of Clinical Experience I. In addition to doing the procedures learned in the first semester, the student observes more complex examinations and gradually assumes an increasing amount of responsibility for the performance of these procedures. The sections on Observation of Procedures and Practicum with Supervision in Clinical Experience I would follow the same outline in this course. Proficiency which the student should have achieved by the end of this second semester includes:

A. An increase in self-confidence
B. Improved interpersonal relationships
C. Ability to apply the principles of exposure factors employing a technique chart
D. A preliminary ability to utilize correct exposure technique in extraordinary situations
E. Competency in the radiography of the:
    1. Digestive tract
    2. Urinary tract
    3. Biliary tract
    4. Vertebral column
    5. Skull and contents
    6. Dentals
    7. Chest

Clinical Experience III

HOURS PER WEEK

Practicum, 18

Course Description

Practical experience in this third semester, for the most part, should be concentrated in the observation and practice of special radiographic procedures, operating room radiographic technique, and bedside examinations. Because of the complexity of equipment used, and the necessity to obtain optimum results on the initial examination, students may not become adept enough in these procedures to work completely without supervision. However, every attempt should be made to allow the student to gain a certain degree of proficiency in these areas. At the end of this practical phase, the student should be competent to:

- A. Adequately perform most bedside examinations unaided
- B. Efficently operate the intricate apparatus commonly used in special radiographic procedures
- C. Achieve proficiency in certain selected procedures
- D. Perform complex specialized procedures under close supervision
- E. Assist technologist in the operating room with the more difficult radiographic examinations, and carry out the more common ones with some supervision

Major Divisions

	Practicum Hours
I. Bedside Radiography	54
II. Procedures	162
III. Operating Room Radiography	72
Total	288

Units of Instruction

- I. Bedside Radiography
  - A. Familiarization with mobile equipment and available electrical outlets
    - 1. Maximum operating potential
    - 2. Adjustment of line voltage compensator
    - 3. Dextrous manipulation of unit
  - B. Selection of technical factors
    - 1. Limitation of x-ray tube
    - 2. Conversion factors
    - 3. Necessity of minimum exposure time
  - C. Radiographic procedure
    - 1. Condition of patient
    - 2. Tube-patient-film relationship
    - 3. Isolation technique, when required
    - 4. Necessity for safety precautions
      - a. Use of oxygen
      - b. Movement of patient
      - c. Presence of accessory apparatus
  - D. Practicum with supervision
  - E. Eventual assumption of responsibility for bedside radiography by the student
- II. Special Procedures
  - A. Familiarization with specialized equipment
    - 1. Rapid film changers
      - a. Single-plane
      - b. Bi-plane
      - c. Cut film
      - d. Roll film
    - 2. Pressure injectors
      - a. Mechanical
      - b. Manual
    - 3. Radiographic tables
      - a. Moveable table tops
      - b. Curved table tops
      - c. Extremity angiogram tables
    - 4. Cardiac monitor and defibrillator
  - B. Preliminary preparation for special procedures
    - 1. Loading of magazines
    - 2. Programming the film changer
    - 3. Loading of pressure injector
    - 4. Verification of availability of emergency equipment
    - 5. Arrangement of sterile pack, gloves, etc.
  - C. Surgical and radiographic procedures
    - 1. Patient preparation and preliminary radiographic examination
    - 2. Utilizing aseptic technique in assisting surgeon
      - a. Opening and handling sterile packs and contents
      - b. Gowning and gloving
    - 3. Final patient-positioning for radiographic examination
    - 4. Selection of technical factors
    - 5. Activation of film changer and injector
  - D. Student observation of procedure
  - E. Practicum under close supervision
  - F. Assumption of increasing responsibility for procedure

III. Operating Room Radiography
  A. Familiarization with surgical and radiographic equipment
    1. Surgical tables
      a. General
      b. Orthopedic
    2. Mobile or overhead radiographic units
    3. Cassette tunnel
    4. Polaroid radiographic unit
    5. Special attachments for surgical outlets
  B. Necessity for re-emphasis of surgical aseptic technique
  C. Selection of exposure factors
  D. Tube(s)-film-part alignment
  E. Importance of speed with accuracy
    1. Patient under anesthetic
    2. Completion of surgical procedure is dependent upon diagnostic radiograph
  F. Processing techniques
    1. Automatic in surgery or radiology
    2. Manual in surgery
      a. Hot solutions
      b. High-speed chemicals
    3. Polaroid
  G. Practicum under close supervision
  H. Eventual assumption of responsibility for surgical radiographic procedures

Clinical Experience IV

HOURS PER WEEK

Practicum, 18

Course Description

Clinical experience in the fourth semester is primarily spent in continuous practice in perfecting the techniques and procedures previously experienced. In addition, some time should be devoted to enable the student to gain limited experience in radiation therapy, nuclear medicine technology, and pediatric radiography. If experience in any of these areas cannot be offered in the hospital where the student is receiving the practicum, affiliation with an institution having the needed facilities should be provided. This semester should also be utilized to give individual students the opportunity to make up any specific deficiencies which were manifested in previous clinical experiences.

Following the above clinical experience, a six-month internship is required to meet accreditation standards. At the completion of the internship, the student should meet the following behavioral objectives:

1. Given a hospital situation, the student will identify all patients who should be given emergency care according to the standards maintained by the hospitals.
2. Given any patient requiring emergency care, the student will perform the appropriate emergency procedures, which could include administering external cardiac resuscitation, lung ventilation, or oxygen, according to the standards maintained by the hospitals.
3. Given any patient requiring an injection or having a contagious disease or operative procedure, the student will maintain asepsis in all such cases according to the standards maintained by the regional hospitals.
4. Given any patient, the student will instruct the patient by whatever method can best be understood, including interpreter, sign language, demonstrations. This will also include what the examination requires of the student, including breathing techniques, and what items must be removed from the patient's person which would cause an artifact or obscure possible pathology to obtain a diagnostic radiograph according to the standards of the supervising radiologists.
5. Given an ambulatory patient, a wheelchair patient, or a guerney patient, the student will physically assist or move the patient into each of the required positions for all radiological examinations by using the medically accepted standard of body mechanic methods without injuring himself or the patient.
6. Given any patient for radiographic and fluroscopic procedures, the student will maintain radiation protection measures to minimize radiation exposure to himself and the patient as stated in the National Council on Radiation Protection Measurements Handbook.
7. Given any patient, the student will evaluate the diagnosis, the age, and body habitus, and select the accurate technical exposure factors to obtain a diagnostic radiograph to the standards of the supervising radiologists.
8. Given a patient, the student will take diagnostically acceptable radiographs of any or all parts of the body (anatomy) according to the standards of the supervising radiologists.
9. Given a standard processing room, the student will store, handle and process any or all film using either manual or automatic processing without artifacts according to the departmental standards of the regional hospitals.
10. Given a radiographic room equipped for special procedures, the student will operate automatic film changers and pressure injectors according to the standards maintained by the special procedures technologist supervisor.
11. Given any patient, the student will obtain and prepare the patient information for billing and film identification for all radiologic procedures and retrieve such information, including previous radiographs, according to the standards of the regional hospitals.
12. Given 200 objective, multiple-choice test items administered by the American Registry of Radiologic Technologists, the radiologic technologist shall answer correctly 75% of those questions. The test items relate to and include questions from the following subject areas: radiographic techniques, standard positioning, anatomy & physiology, x-ray physics and electricity, darkroom, special procedures, radiation therapy, radiation protection, professionional ethics and related nursing, and medical terminology.

Darkroom Chemistry and Technique

HOURS PER WEEK
Class, 1

Course Description

This course covers the subjects of darkroom chemistry and technique. The principles of processing x-ray film are presented from the standpoint of manual as well as automatic processing methods.

Major Divisions

		Class Hours
I.	Darkroom Construction and Equipment	1
II.	X-ray Film	2
III.	Processing Solutions	1
IV.	Techniques for Processing Radiographic Films	3
V.	Automatic Film Processing	5
VI.	Practical Application of Darkroom Techniques	4
	Total	16

Units of Instruction

- I. Darkroom Construction and Equipment
    - A. Manual processing
    - B. Automatic processing
- II. X-ray Film
    - A. Characteristics and composition
    - B. Handling of x-ray film
- III. Processing Solutions
    - A. Ingredients and action of each
    - B. Preparation of solutions
        - 1. Liquid chemicals
        - 2. Dry chemicals
- IV. Techniques for Processing Radiographic Films
    - A. Manual method of time-temperature processing
        - 1. Replenisher system of development recommended
        - 2. Exhaustion system and sight developing not recommended
    - B. Automatic processor systems
    - C. Processing films for photoflurography and cinefluorography
- V. Automatic Film Processing
    - A. Main sections
        - 1. Film-feeding section
        - 2. Film-processing section
        - 3. Film-dryer section
    - B. Essential systems
        - 1. Transport system
        - 2. Water system
        - 3. Recirculation system
        - 4. Replenishment system
        - 5. Dryer system
    - C. Chemistry of automatic processing
        - 1. Special chemical system for rapid processing
        - 2. Warmer processing solutions
    - D. Maintenance and cleaning
        - 1. Daily
        - 2. Periodically
- VI. Practical Application of Darkroom Techniques
    - A. Manual processing
        - 1. Preparation of processing solutions
        - 2. Processing of radiographs
            - a. Time-temperature procedures
            - b. Pitfalls of sight development
    - B. Automatic processing
        - 1. Processing of radiographs
        - 2. Cleaning of processor

Texts and References

Bloom and others. *Medical Radiographic Technique*
Cahoon. *Formulating X-ray Techniques*
Eastman Kodak Company. *Fundamentals of Radiography*
E.I. du Pont de Nemours & Co., Inc., *Darkroom Technique*
______________. *Minutes That Matter*
Fuchs. *Principles of Radiographic Exposure and Processing*
General Electric. *A Look at X-ray Film Processing*
Selman. *The Fundamentals of X-ray and Radium Physics*

Visual Aids

Slides:
Contact your local film representative.

Patient Care and Ethics Pertinent to Radiology

HOURS PER WEEK

Class, 1

Course Description

This course, given early in the student's education, is intended to give the student the basic knowledge concerning patient care and ethical situations with which the radiologic technologist must be familiar. Various ethical considerations have been integrated into the patient care topics wherever they are considered pertinent to the nursing procedure. Class time is allotted for the student to practice certain techniques pertinent to obtaining vital signs, syringe technique, and first-aid measures including artificial respiration, etc.

Major Divisions

	Class Hours
I. Concept of the Health Team	1
II. Ethical and Legal Considerations for Total Patient Care	3
III. Integration of Patient Care and Ethics	12
Total	16

Units of Instruction

- I. Concept of the Health Team
  - A. Description of the health team
  - B. Responsibility of health team members
  - C. Importance of teamwork to accomplish ultimate aim
- II. Ethical and Legal Considerations for Total Patient Care
  - A. Attention to patient's physical as well as radiographical needs
  - B. Complete patient care imperative, not suggested
  - C. Environmental control of the radiology department
  - D. Confidential knowledge
    - 1. About the patient
    - 2. About the institution and fellow employees
  - E. Professional adjustment
  - F. Loaning of films
  - G. Ordering examinations
  - H. Ownership of equipment
  - I. Visitors in radiologic rooms
  - J. Professional bearing
    - 1. Appearance
    - 2. Manner of speech
    - 3. Uniform
    - 4. Courtesy
- III. Integration of Patient Care and Ethics
  - A. Assisting the patient
    - 1. Practical applications
      - a. Into and out of wheelchair
      - b. From stretcher to table
      - c. Undressing ill patient or changing gown
      - d. Turning patient
    - 2. Ethical reasons
      - a. Psychological comfort to patient
      - b. Patient respects technologist, resulting in better cooperation
      - c. Patient feels "cared for" by technologist
  - B. Handling of a seriously ill, injured, or surgical patient
    - 1. Emergency care
      - a. First aid
      - b. Acute abdomen
      - c. Cervical spine injury
      - d. Long bone fractures
      - e. Skull injuries
      - f. Surgical emergencies
    - 2. Moral implications
      - a. Importance of utilizing best quality care possible
      - b. Patient frequently exposed due to condition
        - (1) Provide privacy
        - (2) Keep patient exposed as short a time as possible
  - C. Aseptic technique
    - 1. Asepsis, antisepsis, sterilization, and disinfection
    - 2. Handling techniques
      - a. Sterile articles
      - b. Instruments
      - c. Syringes and needles
      - d. Opening sterile packs
    - 3. Gown technique
  - D. Handling emergencies in a radiology department
    - 1. Whom to call and when
    - 2. Emergency cart contents
    - 3. First aid until the doctor arrives

E. Splints and bandages
  1. Various types
  2. Purposes
  3. Removing and reapplying by the technologist
    a. Never without the doctor's approval
    b. Importance of using care and accuracy

F. Injections
  1. Principles of injection technique
    a. Proper technique for assembling and loading syringe
    b. Practice in syringe technique
  2. Ethical and legal problems of technologist doing injections
    a. Is technologist sufficiently trained for this?
    b. Is technologist legally permitted to do this?
    c. Is technologist capable of handling emergency reaction to injection?
    d. Is the radiologist responsible?
      (1) Will radiologist support technologist?
      (2) May radiologist permit the technologist to inject?

G. Enemas
  1. Administration of enemas
    a. Instructions to the patient
    b. Basic principles of different types of enemas
    c. Tray requisites
    d. Commercial equipment
      (1) Chemical additives
      (2) Tubing, enema tips, etc.
      (3) Disposable equipment
  2. Moral considerations
    a. Ideally, the enema should be administered by technologist of the same sex
    b. Privacy
    c. Expose patient as little as is needed

H. Vital signs
  1. Temperature
  2. Pulse
  3. Blood pressure
  4. Respiration
  5. Practice in obtaining vital signs

I. Catheterization
  1. Purpose
  2. Equipment
  3. Moral considerations
    a. Privacy
    b. Not done by technologist
    c. If technologist is needed, he should be same sex as patient

J. Artificial respiration
  1. Physiology of respiration
  2. Technique of administration

K. Operating room techniques
  1. Surgical asepsis
  2. Aseptic techniques for the technologist to follow

L. Bedside radiography

M. Handling patients with communicable diseases
  1. Aseptic techniques for the technologist
  2. Where and when to do the examination

Texts and References

Chesney. *Care of the Patient in Diagnostic Radiography*

Fuerst and Wolff. *Fundamentals of Nursing*

Ohnysty. *Aids to Ethics and Professional Conduct for Student Radiologic Technologists*

Rothweiler. *Art and Science of Nursing*

Visual Aids

Motion Pictures:

The Chain of Asepsis. 25 min., 16 mm., b & w. American Hospital Association, 840 North Lake Shore Drive, Chicago 11, Illinois.
Summary: Designed to teach hospital corpsmen sterile technique and its absolute necessity. Emphasis on the chain of asepsis during surgery.

Hospital Sepsis, a Communicable Disease. 27 min., 16 mm., sd., b & w. American Medical Association, Committee on Medical Motion Pictures, 535 North Dearborn St., Chicago 10, Illinois.
Summary: Designed to educate all levels of hospital personnel concerning the many avenues by which infection can be spread throughout a hospital. Utilizes the staphylococcus by way of illustration and as an example of one of the most important phases of the problem.

Isolation Technique. 16 min., 16 mm., sd., b & w. Director, Medical Film Library, National Naval Medical Center, Bethesda, Maryland.
Summary: Shows isolation technique that must be used in communicable disease cases.

Mouth-to-Mouth Resuscitation for Respiratory Emergencies. 18 min., 16 mm., sd., color. American Medical Association, Committee on Medical Motion Pictures, 535 North Dearborn St., Chicago 10, Illinois.

Summary: Details the physiologic requirements for effective artificial respiration and outlines the experimental and practical background of the development of mouth-to-mouth resuscitation. Regular and slow motion views depict the preferred techniques for mouth-to-mouth and for mouth-to-nose resuscitation for children and adults.

The Patient is a Person. 20 min., 16 mm., sd., color. American Medical Association, Committee on Medical Motion Pictures, 535 North Dearborn St., Chicago 10, Illinois.

Summary: Explores the fears and attitudes patients often bring to hospitals. Suggests techniques of non-medical care which may contribute to his rapid recovery. Includes influence on patients' attitudes of physician, admitting clerk, nurse, volunteer, and many others.

Temperature, Pulse and Respiration. 15 min., 16 mm., sd., b & w. Indiana University, Audio-Visual Center, Bloomington, Indiana.

Summary: Shows how to take pulse, the temperature, and respiration count methodically. Points out where the pulse beat may be found.

Transparencies:

Fundamental Nursing Principles. Robert J. Brady Co., 130 Q Street N.E., Washington, D.C.

Radiation Therapy, Radiobiology and Nuclear Medicine Technology

HOURS PER WEEK

Class, 3

Course Description

This course is a study of the use of x-rays in therapy. The course emphasizes the absorption of radiation and its effects upon tissue and tissue recovery rate. The student is also acquainted with the fundamentals of radioisotope technology and the role of the technologist in their use.

Major Divisions

	Class Hours
I. Ionizing Radiations	4
II. Radiation Therapy	20
III. Fundamental Concepts of Radioactivity	8
IV. Diagnostic Use of Radioisotopes	16
Total	48

Units of Instruction

- I. Ionizing Radiations
  - A. The atom
  - B. Alpha, Beta particles
  - C. Electromagnetic radiation x and alpha rays
  - D. Interaction of radiation and matter
    - 1. Photons
    - 2. Photoelectric effect
    - 3. Compton scattering effect
    - 4. Pair production
    - 5. Electrons
    - 6. Inelastic collision, excitation, ionization
    - 7. Bremsstrahlung, elastic collision, K-capture
    - 8. Internal conversion, etc.
- II. Radiation Therapy
  - A. Calibration
    - 1. When, why, how
    - 2. Bragg-Gray theory
    - 3. Different types of dosimeters
  - B. Other methods
    - 1. Chemical
    - 2. Photographic
    - 3. Thermal
  - C. Radiation units
    - 1. Roentgen
    - 2. Rad
    - 3. Rep
    - 4. Rem
  - D. Quantity of radiation
    - 1. Intensity dose rate
    - 2. Inverse square law
  - E. Quality of radiation
    - 1. Absorption
    - 2. Half-value layer
    - 3. Filters
  - F. Dosage
    - 1. Air dose
    - 2. Skin dose
    - 3. Backscattering dose
    - 4. Maximum dose
    - 5. Depth dose
    - 6. Integral dose
  - G. Factors affecting
    - 1. Backscattered dose
    - 2. Depth dose
  - H. Therapy equipment
    - 1. Superficial
    - 2. Orthovoltage
    - 3. Megavoltage
  - I. Types
    - 1. Resonant transformer
    - 2. Van de Graaff
    - 3. Linear accelerators
    - 4. Betatron—Cyclotron
    - 5. Gamma Ray teletherapy
      - a. Radium
      - b. Cobalt
      - c. Cesium
  - J. Isodose curves
    - 1. Construction and meaning
    - 2. Summation of isodose curves
    - 3. Single field therapy
    - 4. Parallel opposed fields
    - 5. Multiple ports
  - K. Treatment technics
    - 1. Localization films
    - 2. Compensating filters
    - 3. Computer calculations
  - L. Cancer
    - 1. Definition
    - 2. Statistics
    - 3. Detection
    - 4. General pathological features
    - 5. Growth and spread
  - M. Review of tumors and treatment
    - 1. Central nervous system

2. Eye, ear, nose and paranasal sinuses
3. Oral cavity and oropharynx
4. Larynx and pharynx
5. Respiratory (lung)
6. Gastrointestinal
7. Kidney, ureter, bladder
8. Prostate, testis and penis
9. Uterine cervix
10. Endometrium
11. Ovary, vagina and vulva
12. Breast
13. Leukemia and lymphoma
14. Bone and soft tissue tumors
15. Fundamental cell biology
    a. Structure of cell, chromosomes (DNA)
    b. Reproduction (mitosis and cell divi-
    c. Cell cycle

N. Effect of radiation on cells
  1. Genetic
  2. Somatic
  3. Radiation sensitivity
    a. Cell survival curves
    b. Synchronization of cell populations

O. Radiation effects on man
  1. Local (tissues)
  2. Delayed effects
    a. Genetic
    b. Increased tumor incidence
    c. Life span shortening
    d. Growth and development defects

P. Radiation sickness
  1. Cause and symptoms
  2. Doses
  3. Effects on different organs

Q. How radiation acts

R. Therapeutic implications

S. Application of radiation biology to the treatment of cancer

III. Fundamental Concepts of Radioactivity
  A. Natural
  B. Artificial
  C. Nuclear fision
  D. Nuclear reactions
  E. Radioactive decay
  F. Disintegration constant
  G. Half-life
    1. Physical
    2. Biological
    3. Effective
  H. Average life
  I. Specific activity
  J. Radioactive equilibrium
  K. Unit of radioactivity
    1. Curie, millicurie
    2. Gamma factor
  L. Geiger Mueller
  M. Scintillation counter
  N. Devices for counting detector pulses
    1. Scaler
    2. Count rate meter
    3. Well counter
  O. Statistics of counting
    1. Background
    2. Statistical error
    3. Coincidence loss
  P. General types of counting
    1. Absolute
    2. Comparative
  Q. Scanning
    1. Principle, techniques
    2. Equipment

IV. Diagnostic Use of Radioisotopes
  A. Localization of brain tumors
  B. Thyroid gland (I-131 uptake, scan, T_3 test)
  C. Bone scanning (Strontium-85, Strontium-87)
  D. Lung scanning
  E. Bone marrow scanning
  F. Liver scanning
    1. Indium I-131
    2. Rose Bengal I-131
    3. Au-198
  G. Radioactive Cr in RBC studies
    1. Co-60 Vitamin B_{12} — Pernicious Anemia (Schilling's Test)
    2. Fe-59—Anemias
    3. Blood volume studies
  H. Radioactive isotopes in therapy
    1. I-131—thyroid
    2. Au-198—malignant effusions
    3. P-32—polycythemia
  I. Radium and substitutes
    1. Types of application
      a. Interstitial therapy
      b. Intracavitary therapy
      c. Instillation and/or therapy
    2. Sources
      a. Tubes
      b. Needles
      c. Seeds
      d. Grains
  J. Protection
    1. External sources

2. Internal administration of isotopes
3. Shielding
4. Maximum permissible dose

Texts and References

Early and others, *Textbooks of Nuclear Medicine Technology*
Fields and Seed, *Clinical Use of Radioisotopes*
Glasser and others, *Physical Foundations of Radiology*
Low-Beer, *The Clinical Use of Radioactive Isotopes*
Moss, *Therapeutic Radiology*
Pohle, *Clinical Radiation Therapy*
Quimby and others, *Radioactive Isotopes in Clinical Practice*
Selman, *The Basic Physics of Radiation Therapy*
——————————, *The Fundamentals of X-ray and Radium Physics*
Smullen, *Basic Foundations of Isotope Technique for Technicians*

Radiologic Pathology

HOURS PER WEEK

Class, 2

Course Description

This course is a presentation of the more commonly-encountered lesions of the human body as seen through the medium of x-ray. Anatomy and physiology of pathologic processes is presented by body systems as a means of exploring the rationale of many intricate radiologic examinations. Informed technologists perform at a much higher level of proficiency.

Major Divisions

	Class Hours
I. Development Potential and Pathologic Terminology	4
II. Heart and Lungs	4
III. Skull	6
IV. Urinary Tract	6
V. Digestive System	6
VI. Extremities	6
Total	32

Units of Instruction

- I. Development Potential and Pathologic Terminology
  - A. Basic germ layers
  - B. Tumor
    - 1. Benign
    - 2. Malignant
  - C. Metastatic lesions
  - D. Kinds of cancer
    - 1. Sarcoma
    - 2. Carcinoma
  - E. Trauma
    - 1. Bone fracture
      - a. Simple fractures
        - (1) Greenstick
        - (2) Comminuted
      - b. Compound fractures
    - 2. Foreign body
    - 3. Soft tissue
    - 4. Lacerations
    - 5. Contusions
    - 6. Perforation
  - F. Inflammation
    - 1. Virus
    - 2. Bacteria
    - 3. Fungus
    - 4. Rickettsia
- II. Lesions Affecting the Heart and Lungs, Demonstrated by Radiographs
  - A. Cardiovascular system
    - 1. Rheumatic heart disease
    - 2. Congenital heart disease
    - 3. Hypertensive disease
    - 4. Abnormalities of the arteries, veins, and the lymphatic system
  - B. Respiratory tract
    - 1. Pneumonia
    - 2. Bronchiectasis
    - 3. Tuberculosis
    - 4. Atelectasis
    - 5. Emphysema
    - 6. Foreign bodies in air passages
    - 7. Tumors
    - 8. Pleurisy
    - 9. Empyema
    - 10. Pneumothorax
- III. Lesions Affecting the Skull, Demonstrated by Radiographs
  - A. Anomalies and diseases
    - 1. Congenital anomalies
      - a. Premature synostosis
      - b. Brain growths
      - c. Spina bifida
      - d. Hydrocephalus
    - 2. Infections
      - a. Mastoiditis
      - b. Sinusitis
    - 3. Trauma
      - a. Fracture
        - (1) Linear fracture
        - (2) Depressed fracture
        - (3) Blow-out fracture
      - b. Concussion
    - 4. Tumors
      - a. Benign tumors
        - (1) Epidermoid
        - (2) Cholesteatoma
      - b. Malignant tumors
  - B. Local manifestations of a generalized disease
    - 1. Separation of sutures
      - a. Increase in size of the brain
      - b. Space-occupying mass or lesion
      - c. Conditions that might cause separation

(1) Lead poisoning
(2) Leukemia
2. Excessive number of sutural bones
a. Lamboidal suture bones
b. Periosteal osteogenesis imperfecta
c. Craniocleidodysostosis
d. Cretinism
3. Demineralized skull or atrophy
a. Parathyroid gland
b. Anything that causes anemia
4. Sclerotic skull
a. Paget's disease
b. Fibrous dysplasia
c. Marble bones
5. Post-operative
a. Burr holes
b. Craniotomy
c. Linear craniectomy

IV. Urinary Tract, Demonstrated by Radiographs
A. Review of anatomy and physiology
B. Diseases of the urinary tract
1. Early or minimal inflammation
a. Calyceal unsharpness
b. Striated pelvis
2. Hydronephrosis
a. Early
b. Middle
c. Late
3. Trauma
a. Hematuria
b. Hema section of kidney
4. Tumors
a. Benign
b. Malignant
(1) Wilms tumor
(2) Hypernephroma
(3) Neuroblastoma

V. Digestive System, Demonstrated by Radiographs
A. Esophagus
1. Atresia
2. Varices
3. Foreign bodies
4. Diverticula
B. Stomach
1. Ulcers
2. Carcinomas and other neoplasms
C. Colon and small bowel
1. Diverticulitis
2. Intestinal obstruction
3. Peritonitis
4. Ulcerative colitis
5. Ascites

VI. Extremities, Demonstrated by Radiographs
A. Common anomalies
B. Fractures and dislocations
C. Effects of aging, disuse, etc.
D. Common diseases affecting bones and joints
1. Nutritional deficiency
a. Rickets
b. Scurvy
2. Osteochondritis
3. Arthritis
4. Infections
5. Metabolic diseases
6. Neoplasms
a. Primary
b. Secondary

Texts and References

Boyd. *An Introduction to the Study of Disease*
Brinkbok. *Pathology for Radiographers*
Brodeur. *Radiologic Pathology for Allied Health Professionals*
Fuerst and Wolff. *Fundamentals of Nursing*
Muller and Dawes. *Introduction to Medical Science*

Radiologic Technology I

HOURS PER WEEK

Class, 3; Laboratory, 6

Course Description

This course is designed to give the beginning students an integrated, in-depth coverage of the appendicular skeletal system, ribs, sternum and sternoclavicular joints. The students will be instructed in every phase of radiologic technology with each anatomic system. For every area of the body, this course is designed to impart to students a basic understanding of the anatomy, physiology and medical terminology relating to that area, and the radiation protective measures they must observe. They will be made aware of the questions they should ask to obtain a clinical history, the radiographic views they should take consistent with the suspected pathological condition of the patient, and the radiographic accessories necessary. This course will focus study on the method of positioning the patient, establishment of exposure factors, and the critical analysis of a radiograph from the standpoint of positioning and radiographic quality. This is not a comprehensive outline for each system but a suggested guide to be elaborated upon by the radiologic technology instructor.

Major Divisions

	Class Hours	*Lab Hours*
I. Orientation	3	6
II. Introduction	3	
III. Integrated Approach to Upper Extremity, Shoulder Girdle, Ribs, Sternum, Sternoclavicular Joints, Lower Extremity, and the Pelvic Girdle	42	90
Total	48	96

Units of Instruction

- I. Orientation
  - A. Orientation to the program in radiologic technology
    - 1. Clinical experience
    - 2. General education courses
      - a. Transfer courses
      - b. Terminal courses
  - B. Orientation to the hospital, its departments
    - 1. Specific information on the department of radiology
    - 2. Interdepartmental activities and relationships.
  - C. Orientation to the field of radiologic technology
    - 1. Job opportunities
    - 2. Advanced training
      - a. Baccalaureate
      - b. Continuing education
    - 3. Professional organizations
      - a. The American Registry of Radiologic Technologists
        - (1) Certification
        - (2) Licensing
        - (3) Federal minimal standards
      - b. The American Society of Radiologic Technologists
      - c. State and local societies
- II. Introduction
  - A. Nomenclature of positioning
    - 1. General terminology
    - 2. The planes of the body
    - 3. Terminology of x-ray projections
    - 4. Body positions
  - B. Importance of standard positions
  - C. Examination to be made at right angles to each other
  - D. Examination of parts that form an angle with the film
  - E. Radiography through casts and splints
  - F. Formation of bones
- III. Integrated Approach to the Upper Extremity, Shoulder Girdle, Ribs, Sternum, Sternoclavicular Joints, Lower Extremity, and the Pelvic Girdle

Each of the above areas will be inclusive of the following aspects of radiologic technology:

- A. Anatomy
  - 1. Osseus system
    - a. Bones
      - (1) Long bones
      - (2) Short bones
      - (3) Flat bones
      - (4) Irregular bones
    - b. Number and position of bones in each area
    - c. Anatomic projections and depressions
    - d. Joints
      - (1) Areas of articulation
      - (2) Classified according to their movability

2. Upper extremity
   a. The hand and wrist
      (1) Phalanges
      (2) Metacarpals
      (3) Carpals
   b. The forearm
      (1) Radius
      (2) Ulna
   c. The elbow joint
   d. The arm-humerus
3. Shoulder girdle
   a. Shoulder girdle
      (1) Glenoid fossa of the scapula
      (2) Head of the humerus
   b. Clavicle
      (1) Sternal extremity
      (2) Acromial extremity
   c. Scapula
      (1) Anterior and posterior surfaces
      (2) Superior, vertebral and axillary borders
      (3) Inferior, lateral and medial angles
      (4) Acromion
      (5) Coracoid process
   d. Proximal humerus
4. Ribs, sternum, sternoclavicular joints
   a. Ribs
      (1) True ribs
      (2) False ribs
      (3) Floating ribs
   b. Sternum
      (1) Manubrium
      (2) Body
      (3) Xiphoid
   c. Sternoclavicular joints
5. Lower extremity
   a. The foot and ankle joint
      (1) Phalanges
      (2) Metatarsals
      (3) Tarsals
   b. The leg
      (1) Tibia
      (2) Fibula
   c. The knee joint
      (1) Articulating surfaces
      (2) Patella
   d. The thigh—femur
6. Pelvic girdle
   a. Bones of the pelvis
      (1) Ilium
      (2) Ischium
      (3) Pubis
   b. Sacroiliac joints
      (1) Lateral borders of sacrum
      (2) Posterior border of ilium
   c. Hip joint
      (1) Acetabulum
      (2) Head of femur

B. Terminology
   1. Terminology of x-ray projections
   2. Anatomical terminology
      a. Radiographic landmarks
      b. The planes of the body
   3. Terminology of radiographic accessories
   4. Protection terminology
   5. Terminology of exposure factors
   6. Patient care terminology
   7. Terminology of radiographic positioning

C. Clinical history
   1. Initial examination
      a. Trauma
      b. Pathologic conditions
      c. Foreign body
   2. Follow-up examination
      a. Check progress of therapy
      b. Determine if a change in therapy is warranted
   3. Examination dependent upon clinical history
      a. Effect of pathological condition upon the radiopacity of structures
      b. Selection of exposure factors according to clinical history and the pathologic condition

D. Standard radiographic views
   1. Standard views not the same in all institutions
   2. Chief radiologist of each institution selects standard views he prefers
   3. Importance of multiple standard views done at right angles to each other
      a. Anterior or posterior view
      b. Lateral view
   4. Should consist of a routine study sufficient to demonstrate the part under examination
      a. May require an erect position
      b. Oblique views frequently standard

E. Special radiographic views
   1. Accessory views performed in addition to standard views
      a. Utilized to demonstrate pathology

not adequately visualized on standard views

- b. Results in a more comprehensive examination
- 2. Selection and use of special views determined by radiologist
  - a. Technologist's responsibility to know when and what special views are to be taken
  - b. Some special views frequently modified according to radiologist's preferences
- F. Radiographic accessories
  - 1. Their aid in solving problems
  - 2. Supplementary devices essential to the examination
    - a. Screen or non-screen film holders
    - b. Various film sizes
    - c. Sandbags for immobilization
    - d. Lead markers
    - e. Lead masks
    - f. Plastic steps
    - g. Caliper
    - h. Cola blocks
    - i. Curved cassette
    - j. Potter bucky diaphragm
    - k. Stationary grid-construction-types
    - l. Weight-bearing bench with film well
    - m. Long strip of gauze bandage for immobilization
    - n. Special cassettes for extremities
    - o. Gonad shields
    - p. Lead gloves and apron
    - q. Filter
- G. Radiation Protection
  - 1. Radiation protection terminology and definition of terms
  - 2. Protection of hospital personnel
    - a. Shielding materials
      - (1) Requirements for their use
      - (2) Thickness of protective material depends on its density
    - b. Shielding requirements of the diagnostic room
      - (1) Thickness of lead for ceilings, floors, doors, and walls
      - (2) Control booth requirements
        - (a) Height of walls
        - (b) Leaded glass window
        - (c) Secondary protective barrier
  - 3. Devices reducing radiation to personnel
    - a. Mobile lead screens
      - (1) Not a "method of choice"
      - (2) Must have 1.5 mm. of lead
      - (3) Must not be used above 125 KVP
    - b. Length of exposure cord
      - (1) Fixed unit
      - (2) Mobile unit
    - c. Lead gloves and aprons
      - (1) To be worn during fluoroscopy
      - (2) To be worn by parents and other non-technologist personnel who may assist by holding the patient
      - (3) Lead thickness of .25 mm. required
    - d. Distance
      - (1) Least expensive and most readily available means of protection
      - (2) Use of the inverse square law
    - e. Position of technologist during fluoroscopy
      - (1) Behind control booth or behind radiologist when not assisting him
      - (2) Wear lead apron
      - (3) Keep as much distance from table as possible
      - (4) Fluoroscopic screen has lead to protect radiologist and technologist
  - 4. Personnel monitoring
    - a. Film badge
    - b. Pocket dosimeters
    - c. Other
  - 5. Protection of the patient
    - a. Devices reducing radiation to patient and personnel
      - (1) Proper tube-housing
        - (a) For protection of patient beneath tube
        - (b) Periodically checked for leakage radiation
        - (c) Leakage radiation usually small in amount but certainly unnecessary
        - (d) If it is excessive, must use some absorbing material (usually lead paper) and wrap around tube—ray proofing
      - (2) Gonadal shielding
        - (a) Improper usage can result in genetic implications
        - (b) Especially important with children
        - (c) Different departments have different types

      (i) Must cover correct area
      (ii) If positioned improperly, they can obscure pathology around hip area
  (3) Beam restrictors
    (a) Collimators, cones and diaphragms must be used to restrict the useful beam to area of interest
      (i) They must be calibrated in terms of size of beam at a specified distance
      (ii) Should be equipped with light localizer to define entire field
      (iii) Should produce a visible indication of collimation on the processed radiograph
    (b) Collimation with infants especially important to avoid whole body radiation
    (c) Especially important to use collimation with chest radiography at a 72" FFD.
      (i) Can easily expose gonadal region
      (ii) Provide lead shield if necessary for the pregnant patient
    (d) Avoid radiation to pregnant patient, but this decided by patient's physician
  (4) Filtration
    (a) Removes relatively soft rays that do not do much to expose the film, but would be absorbed by the skin, increasing the patients exposure to radiation
    (b) Filter is placed in tube housing at the aperture
    (c) Minimum total filtration required is 2.5 mm. aluminum
H. Exposure factors
  1. Accurate selection of exposure factors essential to good radiographic quality
  2. Factors affecting selection of exposure factors
    a. Size of the part
    b. Age of the patient
    c. Pathologic condition of the patient
    d. Phase of respiration
    e. Screen or non-screen film holder
    f. Film speed
    g. Screen speed
      (1) Composition of screens
      (2) Intensification factors
    h. Amount of filtration
    i. Casts, splints or dressings
    j. Bucky or table top
    k. Type of technique chart being utilized
    l. Capacity and efficiency of unit being used
    m. Processing cycle efficiency
    n. Heel effect
    o. Grid ratio and radius-lines per inch
    p. Tube rating chart
    q. Anode cooling chart
  3. Proper selection of prime factors
    a. Kilovoltage
    b. Milliamperage
    c. Time
    d. Distance
I. Radiographic positioning
  1. Standard views
    a. Determined by chief radiologist
    b. Done routinely unless contraindicated
  2. Special views
    a. Determined by chief radiologist
    b. Done to supplement standard views when necessary
    c. Provide a more detailed study
J. Film critique
  1. Completeness of examination
    a. Structures demonstrated
    b. Additional view(s) indicated
  2. Accuracy of positioning
  3. Radiographic quality
    a. Density
    b. Contrast
    c. Definition
    d. Distortion
  4. Proper identification
  5. Evidence of protection

Laboratory (96 hours) Energized X-ray Equipment:

It is recommended that the x-ray equipment on campus be energized, and that 200 clock hours of concentrated phantom-laboratory practice be given in the first two semesters of the program. This would necessitate laboratory periods of six hours per week in the first and second semesters. Three 2-hour laboratory sessions per week are recommended to maintain maximum efficiency. *Again, it must be stressed that x-ray exposure is to be made only on phantoms with all personnel behind protective shielding.*

Laboratory work in this course is devoted to learning and practicing patient care, utilizing the theory presented in this course. The laboratory periods should be conducted in such a way as to insure that the procedure will be demonstrated by the instructor and then practiced by each student under the supervision of the instructor. Laboratory exercises in these skills should begin immediately and should be used throughout the course. Demonstration and practice should include:

1. Use of the caliper to measure the part to be radiographed
2. Familiarization of the accessories available
3. Dexterity in moving the x-ray tube into correct positions
4. Reading the technique charts
5. Manipulation of x-ray controls and setting the machine properly for each examination
6. Use of correct body mechanics and patient care for each examination
7. Positioning the patient for proper part-film-tube relationship
8. Processing the exposed x-ray film (both manual and automatic)
9. Critiquing the student's radiographs by the class under the direct supervision of the instructor

Laboratory time should also be utilized to include experiments in radiation protection and quality of radiographs. Both areas of interest can be adequately demonstrated by many of the same experiments. Examples would include inverse square law, effects of intensifying screens, and effects of filter changes. A suggested method of conducting these experiments is described in the Radiation Safety section in *Radiologic Technology*, page 332 (see bibliography).

Texts and References

Cahoon. *Formulating X-ray Techniques*

Clark. *Positioning in Radiography*

Fuchs. *Principles of Radiographic Exposure and Processing*

Jacobi. *Textbook of Anatomy and Physiology in Radiologic Technology*

Jacobi and Paris. *Textbook of Radiologic Technology*

Mallett. *A Handbook of Anatomy and Physiology for X-ray Technicians*

Merrill. *Atlas of Roentgenographic Positions*

Meschan. *An Atlas of Normal Radiographic Anatomy*

Morgan. *The Art and Science of Medical Radiography*

Selman. *The Fundamentals of X-ray and Radium Physics*

Visual Aids

Motion Pictures:

Diseases of the Gallbladder. 19 min., 16 mm., silent, color. American Cyanamid Co., Surgical Film Library, Surgical Products Division, 1 Casper St., Danbury, Connecticut.

Summary: Shows various types of gallbladder disease with x-rays. This includes small and large gallstones, polyps, gangrene, carcinoma and external fistula.

Radiography, This Is. 18 min., 16 mm., sd., color. Contact local Kodak Technical Sales Representative.

Summary: Devoted to the fundamentals of radiographic exposure and the creation of the fluoroscopic and radiographic image. This movie is entirely in animation and shows how varying the kilovoltage, time, milliamperage, and distance affects the image.

Skeleton. 13 min., 16 mm., sd., b & w. Indiana University, Audio-Visual Center, Bloomington, Indiana.

Summary: Analyzes the human skeleton and examines the function and structure of bones. Uses x-ray photography to show various kinds of movable joints in action. Explains with the help of animation, the growth process and structure of bones and identifies their chemical properties by means of laboratory experiments.

You Can Be Safe From X-rays. 10 min., 16 mm., sd., b & w. Medical Director of Public Health; Federal Security Agency. (Regional Office).

Summary: Depicts danger to personnel of secondary radiation and outlines protective measures against over-exposure. For training x-ray technicians.

Transparencies:

Anatomy and Positioning. General Aniline and Film Corporation, 140 West 51st St., New York, N.Y.

Slides:

Meschan, Isadore. *Normal Radiographic Anatomy.* W.B. Saunders Co., W. Washington Sq., Philadelphia, Pennsylvania.

Radiographs:

Utilization of radiographs for each examination being studied.

Skeleton:

Use of an articulated skeleton to aid teaching of anatomy.

Charts:

Anatomical Charts. Eastman Kodak Company, Audio-Visual Service, Rochester, N.Y.

Phantoms:

The Phantom Patient. Alderson Research Laboratories, Inc., Stamford, Connecticut.

Radiologic Technology II

HOURS PER WEEK

Class, 3; Laboratory, 6

Course Description

This course is a continuation of Radiologic Technology I, in which the student will be given an in-depth integrated coverage of the thoracic viscera, abdomen, digestive system, urinary system, axial skeleton, and dental radiography.

Major Divisions

	Class Hours	*Lab Hours*
I. Integrated Approach to the Thoracic Viscera, Abdomen, Digestive System, Vertebral Column, Skull and Mastoids, Facial Bones, Paranasal Sinuses, and Dental Radiography	46	80
II. Special Equipment for Head and Dental Radiography	2	16
Total	48	96

Units of Instruction

I. Integrated Approach to the Thoracic Viscera, Abdomen, Digestive System, Vertebral Column, Skull and Mastoids, Facial Bones, Paranasal Sinuses, and Dental Radiography

Each of the above areas will be inclusive of the following aspects of radiologic technology:

- A. Anatomy
  - 1. Thoracic viscera
    - a. Trachea
    - b. Bronchi
    - c. Lungs
    - d. Pleura
    - e. Diaphragm
    - f. Mediastinum
  - 2. Abdomen
    - a. Region and limits of the abdomen
    - b. Divisions of the abdomen
    - c. Influence of body build
    - d. Organs located in abdominal cavity
  - 3. Digestive system
    - a. Esophagus
    - b. Stomach
      - (1) Size, shape and position of stomach
      - (2) Cardiac and pyloric portions
      - (3) Physiologic function
    - c. Small intestine
      - (1) Duodenum, jejunum and ileum
      - (2) Physiologic function
    - d. Large intestine
      - (1) Cecum, colon and rectum
      - (2) Physiologic function
    - e. Gallbladder
      - (1) Relation to the biliary tree and the digestive system
      - (2) Concentration and storage function
  - 4. Urinary system
    - a. Upper urinary tract
      - (1) Kidneys
      - (2) Ureters
    - b. Lower urinary tract
      - (1) Bladder
      - (2) Urethra
  - 5. Vertebral column
    - a. The five groups of vertebrae
    - b. Description of vertebrae
    - c. Congenital or developmental anomalies
    - d. Typical and atypical vertebrae
  - 6. The head
    - a. Skull and mastoids
      - (1) The eight bones of the cranium
      - (2) Reference points and lines
    - b. Facial bones
      - (1) The fourteen facial bones
      - (2) Their function of providing a protective housing
    - c. Paranasal sinuses
      - (1) The four sinuses
      - (2) Air-containing cavities
    - d. Teeth
      - (1) Dental arches
      - (2) Deciduous and permanent teeth
      - (3) Parts of the tooth
      - (4) External localization points
- B. Terminology
  - 1. Anatomical terminology
  - 2. Terminology of radiographic accessories
  - 3. Protection terminology
  - 4. Terminology of exposure factors
- C. Opaque media
  - 1. Digestive system

a. Gastrointestinal tract
(1) Barium sulphate or other suitable contrast media
(2) Methods of preparation
(a) Consistency of mixture
(b) Amount of contrast agent
(3) Instruction to patient for ingestion of barium
(4) Administering of barium enema
b. Gallbladder
(1) Opaque media used
(2) Dosage
(3) Instructions to patient
2. Urinary system
a. Intravenous pyelography
(1) Media used
(2) Dosage and loading of syringe
b. Retrograde pyelography
(1) Media used
(2) Preparation of solution
(3) Methods of injection
D. Indications for examination
1. Initial examination
a. Trauma
b. Pathologic conditions
c. Foreign body
2. Follow-up examination
a. Check progress of therapy
b. Determine if a change in therapy is warranted
3. Examination dependent upon clinical history
a. Effect of pathologic condition upon the radiopacity of structures
b. Selection of exposure factors according to clinical history and the pathologic condition
E. Standard radiographic views
1. Standard views not the same in all institutions
2. Chief radiologist of each institution selects standard views he prefers
3. Importance of multiple standard views done at right angles to each other
a. Anterior or posterior view
b. Lateral view
4. Should consist of a routine study sufficient to demonstrate the part under examination
a. May require an erect position
b. Oblique views frequently standard
F. Special radiographic views
1. Accessory views performed in addition to standard views
a. Utilized to demonstrate pathology not adequately visualized on standard views
b. Results in a more comprehensive examination
2. Selection and use of special views determined by chief radiologist
a. Technologist's responsibility to know when and what special views are to be taken
b. Some special views frequently modified according to preference of radiologist
G. Radiographic accessories
1. Their aid in solving problems
2. Supplementary devices essential to the examination
a. Screen or non-screen film holders
b. Various film sizes
c. Sandbags for immobilization
d. Lead markers
f. Potter bucky diaphragm
g. Stationary grid
h. Dental or occlusal film
i. Gonadal shields
j. Lead gloves and apron
k. Filter
H. Radiation protection
1. Importance of reducing radiation exposure to humans
2. Methods of reducing radiation exposure
a. Collimation
b. Filtration
c. Gonadal shielding
d. Lead gloves and aprons
e. Correct positioning and exposure to prevent repeat examinations
f. Each exposure room sufficiently lead protected
I. Exposure factors
1. Accurate selection of exposure factors essential to good radiographic quality
2. Factors affecting selection of exposure factors
a. Size of the part
b. Age of the patient
c. Pathologic condition of the patient
d. Phase of respiration
e. Screen or non-screen film holder
f. Film speed
g. Screen speed

h. Amount of filtration
i. Dressings
j. Bucky or table top
k. Type of technique chart being utilized
l. Capacity and efficiency of unit being used
m. Efficiency of the processing cycle
n. Inverse square law
o. Heel effect
p. Tube rating chart
q. Anode cooling chart
r. Grid ratio, radius, lines per inch
3. Proper selection of prime factors
a. Kilovoltage
b. Millamperage
c. Time
d. Distance
J. Radiographic positioning
1. Standard views
a. Determined by radiologist
b. Done routinely unless contraindicated
2. Film critique
a. Structures demonstrated
b. Accuracy of positioning
c. Radiographic quality
(1) Density
(2) Contrast
(3) Definition
(4) Distortion
II. Special Equipment for Head and Dental Radiography
A. Head units
1. Supplementary equipment
2. Facilitates ease in performance of examinations
3. Correct manipulation of unit
4. Diverse uses
a. Routine examinations
b. Air contrast studies of the brain
c. Radiography of the emergency patient on stretcher
d. As a radiographic unit for small extremities
5. Acessory apparatus
a. Encephalographic chair
b. Beam restrictors
c. Immobilization devices
B. Dental unit
1. Cones
a. Long cone
b. Short cone
2. Extensibility of tube arm
3. Control panel
4. Dental chair
a. Head rest
b. Mobility of chair

Laboratory (96 hours) Energized X-ray Equipment:

Laboratory work in this course is devoted to learning and practicing patient care, utilizing the theory presented in this course. The laboratory periods should be conducted in such a way as to insure that the procedure will be demonstrated by the instructor and then practiced by each student under the supervision of the instructor. Laboratory exercises in these skills should begin immediately and should be used throughout the course. Demonstration and practice should include:

1. Use of the caliper to measure the part to be radiographed
2. Familiarization of the accessories available
3. Dexterity in moving the x-ray tube into correct positions
4. Reading the technique charts
5. Manipulation of x-ray controls and setting the machine properly for each examination
6. Use of correct body mechanics and patient care for each examination
7. Positioning for proper part-film-tube relationship
8. Processing the exposed x-ray film (both manual and automatic)

Any experiments set-up for Radiologic Technology I which were not completed should be conducted during this laboratory session.

Texts and References

Cahoon. *Formulating X-ray Techniques*
Clark. *Positioning in Radiography*
Eastman Kodak Company. *Dental Radiography and Photography*
——————————, X-rays in Denistry
E.I. du Pont de Nemours & Co., Inc., *Fluoroscopy and Radiography of the Gastrointestinal Tract*
Fuchs. *Principles of Radiographic Exposure and Processing*
Jacobi. *Textbook of Anatomy and Physiology in Radiologic Technology*
Jacobi and Paris. *Textbook of Radiologic Technology*
Mallett. *A Handbook of Anatomy and Physiology for Student X-ray Technicians*

Merrill, *Atlas of Normal Radiographic Anatomy*

Meschan, *An Atlas of Normal Radiographic Anatomy*

Morgan, *The Art and Science of Medical Radiography*

Selman, *The Fundamentals of X-ray and Radium Physics*

Visual Aids

Transparencies:

Anatomy and Positioning. General Aniline and Film Corporation, 140 West 51st St., New York, N.Y.

Slides:

Meschan, Isadore. *Normal Radiographic Anatomy.* W.B. Saunders Co., W. Washington Sq., Philadelphia, Pennsylvania.

Radiographs:

Utilization of radiographs for each examination being studied.

Skeleton:

Use of an articulated skeleton to aid teaching of anatomy.

Charts:

Anatomical Charts. Eastman Kodak Company, Audio-Visual Services, Rochester, N.Y.

Phantoms:

The Phantom Patient. Alderson Research Laboratories, Inc., Stamford, Connecticut.

Radiologic Technology III

HOURS PER WEEK

Class, 3

Course Description

This course is designed to give the student a theoretical understanding of specialized and highly technical procedures which are carried out in the department of radiology. It includes the design, function, and maintenance of special radiographic equipment, and the use, indications and contraindications of opaque media. A detailed review of radiographic anatomy of each system will be presented prior to the study of the specific procedures.

Major Divisions

		Class Hours
I.	Special Equipment	3
II.	Neuroradiography	9
III.	The Eye	3
IV.	The Chest	3
V.	The Heart	6
VI.	The Abdomen	6
VII.	Genito-urinary System	3
VIII.	Obstetrics and Gynecology	3
IX.	The Extremities	3
X.	Miscellaneous	9
	Total	48

Units of Instruction

I. Special Radiographic Equipment
  A. High capacity generators
    1. Single phase
    2. Three phase
  B. X-ray tubes
    1. Heavy-duty rotating anode
    2. Focal-spot size
  C. Timers
    1. Standard impulse timer
    2. Elema timer
    3. Dynapulse timer
    4. Phototiming
  D. Automatic rapid film changers
    1. Cut-film changers
    2. Roll-film changers
    3. Cassette changers
    4. Biplane changers
  E. Cineradiography and video-tape recording
  F. Pressure injectors
    1. Manual
    2. Mechanical
      a. CO_2 for pressure
      b. Electrical pump
  G. Rapid film processing equipment
  H. Needles, cannulae and catheters
  I. Cardiac monitor and defibrillator
  J. Image intensifiers
  K. Body section apparatus
II. Neuroradiography
  A. Pneumoencephalography and ventriculography
    1. Review of anatomy of the ventricles of the brain and subarachnoid spaces
    2. Purpose of the procedures
    3. Indications and contraindications
    4. Methods of injection
      a. Lumbar puncture
      b. Surgical procedure
    5. Contrast media used
    6. Types of equipment
      a. Standard radiographic unit
      b. Head unit
      c. Special encephalographic chair
    7. Radiographic examinations
      a. Positioning
      b. Technical factors
  B. Cerebral angiography
    1. Review of the anatomy of the circulatory system of the head and neck
    2. Purpose of the procedure
    3. Indications and contraindications
    4. Opaque media
      a. Water miscible
      b. Non-toxic
      c. Non-irritating
      d. Completely and rapidly excreted from the body
    5. Radiographic equipment
      a. Standard equipment—single exposures
      b. Rapid cassette changers
      c. Biplane equipment
      d. Cine camera
      e. Automatic injectors
    6. Radiographic examination
      a. Positioning
      b. Technical factors
  C. Myelography
    1. Review of the anatomy of the spinal cord

    2. Purpose of the procedure
    3. Indications and contraindications
    4. Opaque media
    5. Methods of injection
      a. Lumbar puncture
      b. Cisternal puncture
    6. Radiographic examination
      a. Fluoroscopy with spot films
      b. Supplementary radiographs
    7. Care of the patient
III. The Eye
  A. Foreign body localization in the eye
    1. Review of anatomy of the eye
    2. Purpose of the procedure
    3. Preliminary examination
    4. Methods of examination
      a. Vogt bone—free projections
      b. Parallax motion method
      c. Sweet method
      d. Pfeiffer-Comberg method
  B. Dacrocystography
    1. Review of anatomy of the lacrimal and naso-lacrimal ducts
    2. Purpose of procedure
    3. Opaque media used
    4. Method of injection
    5. Radiographic examination
IV. The Chest
  A. Bronchography
    1. Review of anatomy of the respiratory system and thoracic cavity
    2. Purpose of the procedure
    3. Indications and contraindications
    4. Opaque media
      a. Iodized oils
      b. Water soluble media
    5. Methods of injection
      a. Supra or transglottic method
      b. Nasal catheter inserted into trachea
      c. Selected segmental bronchography
      d. Intubation of trachea
      e. Cricothyroid method
    6. Equipment and instruments used
    7. Radiographic examination
      a. Positioning of the patient
      b. Technical factors
  B. Kymography
    1. Purpose and indications for technique
    2. Equipment used
      a. Moving film and stationary grid
      b. Electrokymography
    3. Radiographic technique
    [illegible] Instructions to patient
V. The Heart and Aorta
  A. Cardioangiography
    1. Review of anatomy of the chambers of the heart and the great vessels
    2. Purpose of the procedure
    3. Indications and contraindications
    4. Opaque media used
    5. Methods of injection
      a. Antecubital injection
      b. Femoral cut-down
      c. Brachial cut-down
      d. Cardiac catheterization
    6. Radiographic examination
      a. Positioning of the patient
      b. Technical factors
  B. Aortography
    1. Purpose of the procedure
    2. Indications and contraindications
    3. Opaque media
    4. Methods of injection
      a. Femoral artery cut-down
      b. Percutaneous puncture of abdominal aorta
    5. Equipment needed
    6. Radiographic examination
      a. Position of patient
      b. Technical factors
    7. Nephrotomograms
    8. Lower extremity arteriogram
VI. The Abdomen
  A. Pneumoperitoneum
    1. Spontaneous
    2. Artificial
    3. Purpose of procedure
    4. Preparation of patient
    5. Method of injection
    6. Radiographic examination
      a. Position of patient
      b. Technical factors
  B. Hepatosplenoportography
    1. Review of anatomy
    2. Purpose of procedure
    3. Methods of injection
      a. In surgery
      b. Percutaneous puncture into the spleen
    4. Radiographic examination
      a. Positioning of patient
      b. Technical factors
VII. Genito-urinary System
  A. Perirenal insufflation
    1. Review of anatomy
    2. Purpose of procedure

        3. Preparation of patient
        4. Methods of injection
            a. Lumbar puncture
            b. Pre-sacral method
        5. Radiographic positioning and technique
    B. Renal angiography
        1. Purpose of procedures
        2. Indications and contraindications
        3. Types of examinations
            a. Aortography for suprarenal glands
            b. Retrograde aortography under controlled hypotension
            c. Translumbar renal arteriography
        4. Radiographic positioning and technique

VIII. Obstetrics and Gynecology
    A. Pelvimetry, placentography, and amniography
        1. Review of anatomy
        2. Purpose of procedure
        3. Indications and contraindications
        4. Methods
            a. Thoms method
            b. Colcher-Sussman method
            c. Ball method
            d. Other methods
        5. Equipment
        6. Film quality
        7. Radiation protection
        8. Care of patient
        9. Respiration
    B. Uterosalpingography
        1. Review of anatomy
        2. Purpose of the procedure
        3. Preparation of patient
        4. Contrast media used
        5. Appointment date and care of the patient
        6. Film quality
        7. Radiation protection
        8. Radiographic positioning and technical factors
    C. Mammography
        1. Review of anatomy
        2. Methods of exposure
            a. With opaque media
            b. Without opaque media
                (1) Egan technique
                (2) Gershon-Cohen technique
        3. Exposure factors
        4. Positioning of patient
            a. Craniocaudad projection
            b. Mediolateral projection
            c. Axillary projection

IX. Extremities
    A. Scanography
        1. Purpose of the procedure
        2. Methods used
            a. Slit-scanography
            b. Spot scanography
            c. Bell and Thompson spot scanography
        3. Radiographic positioning and technical factors
    B. Arthrography
        1. Purpose of procedure
        2. Contrast media
        3. Method of injection
        4. Radiographic positioning and technical factors
    C. Venography and arteriography of the extremities
        1. Purpose of the procedures
        2. Indications
        3. Opaque media
        4. Equipment and injectors
        5. Methods of injection
            a. Direct venous puncture
            b. Percutaneous arterial catheterization
            c. Percutaneous retrograde femoral puncture
        6. Radiographic positioning and technical factors

X. Miscellaneous
    A. Body section radiography
        1. Principle of the procedure
        2. Types of equipment
        3. Amplitude
        4. Multi-section radiography
        5. Procedure and technique
    B. Sialography
        1. Review of anatomy of the salivary glands
        2. Purpose of the procedure
        3. Opaque media
        4. Supplies needed
        5. Method of injection
        6. Radiographic positioning and technical factors
    C. Sinus tract injection
        1. Paranasal sinus
            a. Anatomy of paranasal sinuses
            b. Methods of injection
                (1) Direct injection
                (2) Displacement method
        2. Sinus tract
            a. Formation of sinus tracts
            b. Supplies needed

3. Opaque media
4. Radiographic positioning and technical factors

Texts and References

Beranbaum and Meyers, *Special Procedures in Roentgen Diagnosis*

Curry and Howland, *Arteriography: Principles and Techniques*

Merrill, *Atlas of Roentgenographic Positions*

Meschan, *An Atlas of Normal Radiographic Anatomy*

Watson, *Patient Care and Special Procedures in Radiologic Technology*

Radiologic Technology IV

HOURS PER WEEK

Class, 3

Course Description

This course is a continuation of special procedures with emphasis placed on pediatric radiography. Radiologic records, as well as teaching principles in radiologic technology programs, are also presented. The skills learned in this course are intended to assist the students in the special techniques of working with children, to prepare them to assume responsibilities in record-keeping, and to introduce them to the concept of education principles. The last four weeks of this course are devoted to comprehensive review.

Major Divisions

	Class Hours
I. Pediatric Radiography	10
II. Radiologic Records	6
III. Teaching in Schools of Radiologic Technology	20
IV. Review for American Registry Examination	12
Total	48

Units of Instruction

- I. Pediatric Radiography
  - A. Importance of a proper psychological approach
    - 1. Approach to the patient varies
      - a. Age of the child
      - b. Physical and mental condition of the child
    - 2. Handling the patient
      - a. The cooperative child
      - b. The uncooperative child
    - 3. Approach to the parents
      - a. Attitude of the technologist
      - b. Courtesy to parents
      - c. Parent-technologist relationship
      - d. Parents as helpers
  - B. Care of the pediatric patient
    - 1. Safety factors
      - a. Keep bed-rails up
      - b. Prevent falls from the table
    - 2. Protection against excessive radiation
    - 3. Prevention of spread of disease
    - 4. Recognition of vital symptoms
    - 5. Isolation technique
    - 6. Handling emergencies
  - C. Technical considerations
    - 1. Equipment
      - a. Generators providing high MA and KVP
      - b. High speed timers
      - c. Immobilization devices
      - d. Accessory devices
    - 2. Exposure factors
    - 3. Construction of the pediatric radiology department
      - a. Location
      - b. Layout
  - D. Upper and lower extremities
    - 1. Development of osseous system
    - 2. Congenital anomalies
    - 3. Routine and special views
    - 4. Radiography of extremities relative to disease
    - 5. Scanography
  - E. Shoulder girdle and thoracic cage
    - 1. Includes shoulder, clavicle, sternum, scapula and ribs
    - 2. Routine and special views
  - F. Chest and mediastinal structures
    - 1. Routine and special views
    - 2. Examinations relative to disease and pathologic conditions
    - 3. Congenital anomalies and examinations of the mediastinal structures
    - 4. Congenital anomalies and examinations of the heart
  - G. Vertebral column
    - 1. Developmental anatomy
    - 2. Congenital and developmental considerations
    - 3. Routine and special views
  - H. Digestive system
    - 1. Abdomen
    - 2. Includes esophagus, stomach, small bowel, and colon
    - 3. Congenital anomalies
    - 4. Developmental pathologic conditions
    - 5. Foreign bodies
    - 6. Routine and special examinations
      - a. Preparation of the patient
      - b. Preparation of the contrast media
  - I. Urinary system
    - 1. Congenital malformations
    - 2. Pathological conditions

    3. Routine and special examinations
  J. Skull
    1. Congenital anomalies
    2. Routine and special examinations
II. Radiologic Records
  A. Setting up and organizing the radiology department filing system
    1. Space
    2. Efficiency
  B. Filing methods
    1. Numerical
    2. Alphabetical
    3. According to "subject"
  C. Color coding
    1. File envelopes for radiographs
    2. Other radiology department color coding needs
  D. Indexing and cross-indexing
    1. Pathologic file
    2. Regular file in department
  E. Microfilming
    1. Radiographs
    2. Reports
  F. Prevention of mis-filing
  G. Terminal and middle digit filing
  H. Filing systems commonly used in radiation
  I. Legal aspects of radiologic records
  J. Reports
  K. Card filing systems
  L. Business forms
    1. Charge slips
    2. Record of expenses
    3. Statistical data
  M. Records of supplies
  N. Employee records
  O. Work schedule records
III. Teaching in Schools of Radiologic Technology
  A. Philosophy, aims and objectives
    1. Philosophy of radiologic technology education
    2. Aims and objectives of the teacher
    3. Objectives of the student
  B. Curriculum planning and development
    1. Concepts of curriculum
    2. Selection and organization of learning experience in the curriculum
    3. Core curriculum
  C. Course planning
    1. Planning course content
    2. Planning semester dates for content presentation
  D. Daily planning
    1. Preparation for content presentation
    2. Following the class plan
  E. Methods of teaching
    1. The lecture method
    2. The demonstration method
    3. Lecture-demonstration method
    4. The laboratory method
  F. Audio-visual materials
    1. Functions and definition of educational communication media
    2. Principles underlying the successful use of audio-visual media
    3. Types of educational communication media
      a. The field trip
      b. 3-dimensional materials
      c. Graphic aids
      d. Exhibits
      e. Flat and projected still pictures
      f. Programmed instruction
      g. Recordings
      h. Motion pictures
      i. Television
      j. Blackboard
  G. Evaluation of the student
    1. Purpose of evaluation
    2. Complexity of evaluation
    3. Steps in evaluation
    4. Evaluation techniques
      a. Preparation of exams
      b. Subjective questions
      c. Objective questions
      d. Scoring
      e. Grading
      f. Evaluating the examination results
  H. Student records and forms
    1. Application
    2. Entrance examination records
    3. Records of grades
    4. Work assignment records
      a. Number and types of clinical exams
      b. Number of clinical and didactic hours completed
  I. Attributes of the instructor
    1. Appearance
    2. Rapport with the students
    3. Professional skill
    4. Speech, voice, and vocabulary
    5. Mannerisms
IV. Review for American Registry Examination
  A. Pre-test covering all areas of radiologic technology
    1. Determine present level of student comprehension

    2. Determine which subject areas to review and to what extent
- B. Review of subject content indicated by pretest results
- C. Post-test
    1. Determine amount of improvement made by review
    2. Determine overall comprehension of subject content
    3. Determine the extent of self-study needed

Texts and References

Brethorst. *Methods of Teaching in Schools of Nursing*

Heidgerken. *Teaching and Learning in Schools of Nursing*

Visual Aids

Motion Pictures:

Instructional Film: The New Way to Greater Education. Indiana University, Audio-Visual Center, Bloomington, Indiana.

Summary: Presents a lecturer who discusses the place of educational motion pictures in the curriculum. As he talks, scenes illustrate slow motion, magnification, and other unusual camera techniques; and the entire film *How to Read a Book* is shown. The lecturer covers the importance of proper selection, integration, and administration of educational motion pictures and the problem of accessibility of general and specialized titles.

Transparencies:

Re-use of transparencies used previously for purpose of review for registry examination.

X-ray Physics

HOURS PER WEEK

Class, 3

Course Description

This course is a study of the fundamentals of magnetism, electricity, and radiation physics, to give the student a basic understanding of the physical principles underlying the production of x-rays and their interaction with matter.

Major Divisions

		Class Hours
I.	Introduction	2
II.	Matter and Atomic Theory	4
III.	Electricity, Static and Current	6
IV.	Magnetism	2
V.	Electromagnetism	4
VI.	Electric Generators and Motors	2
VII.	Production and Control of High Voltage	6
VIII.	Rectification	3
IX.	X-ray and other Tubes	3
X.	X-ray Circuitry	6
XI.	X-rays, their Nature and Production	6
XII.	Types of Modern Equipment in Use	4
	Total	48

Units of Instruction

I. Introduction
  A. Nature of physics
    1. Fundamental units
    2. Derived units
  B. The physical concept of energy
    1. Inertia
    2. Energy
      a. Kinetic
      b. Potential
    3. Law of conservation of energy
II. Molecular and Atomic Theory
  A. The structure of matter
  B. Atomic structure
    1. Nucleus
    2. Shells
    3. Atomic number
    4. Mass number
    5. Isotopes
    6. Valence
  C. Periodic table
  D. Ionization
III. Electricity, Static and Current
  A. Electrostatics
    1. Electrification
      a. By friction
      b. By contact
      c. By induction
    2. Laws of electrostatics
    3. The electroscope
    4. Static discharge
  B. Electrodynamics
    1. The nature of an electric current
    2. Sources of current electricity
    3. Factors in the simple electric circuit
      a. Potential difference
      b. Current strength
      c. Resistance
    4. The connection of meters in a circuit
    5. Ohm's Law
      a. Application in series circuits
      b. Application in parallel circuits
    6. Electric capacitor
    7. The work and power of an electric current
IV. Magnetism
  A. Classification of magnets
  B. Properties of magnets
  C. Characteristics of lines of force
  D. Magnetic induction
  E. Qualities of magnetic materials
V. Electromagnetism
  A. Electromagnetic induction
  B. Induced currents
  C. Self induction
  D. Mutual induction
VI. Electric Generators
  A. Essential features
  B. Direct current generators
  C. Alternating current generator
    1. Frequency
    2. Properties
    3. Advantages
VII. Production and Control of High Voltage
  A. Transformer
    1. Principle
    2. The transformer law
    3. Construction
    4. Types
      a. Step up
      b. Step down
      c. Autotransformer

B. Rheostat
1. Principle
2. Comparison of autotransformer and rheostat
C. Choke coil
VIII. Rectification
A. Purpose
B. Methods of rectifying an alternating current
1. Self-rectification
2. Valve-tube rectification
a. Half wave
b. Full wave
c. Three phase
C. Construction of rectifying devices
1. Similarities and differences with x-ray tubes
2. Solid state rectifiers
IX. X-ray and Other Tubes
A. General features of hot filament tubes
B. Diagnostic x-ray tubes
1. Glass envelope
2. Cathode
3. Anode
C. Roentgen therapy tubes
1. Four kilovoltage ranges
2. Construction
D. Valve tubes
1. Cathode
2. Anode
3. Principles of operation
X. X-ray Circuitry
A. Source of electricity
B. Main x-ray circuits
1. Primary circuit
2. Secondary circuit
C. X-ray control panel
D. Experimentation with x-ray simulator
XI. X-rays, Their Nature and Production
A. Electromagnetic spectrum
B. Necessary conditions for x-ray production
C. Methods of producing x-rays
1. Brems radiation
2. Characteristic radiation
D. The interaction of penetrating radiation and matter
1. Photoelectron collision
2. Unmodified scattering
3. Compton collision
4. Pair production
XII. Types of Modern Equipment in Use
A. Fluoroscopy
1. Conventional type
2. Advances for future
a. Thermography
b. Ultrasonics
B. Cinefluorography
1. Cine camera
2. Cinematography
a. Serial fluorography
b. Cine fluorography
C. Image intensification
1. Electro-optical image intensifier
2. Solid-state amplification
D. Television and cinefluorography
1. The television camera
2. The television receiver
E. Videotape recording
F. Field emission radiography
G. Computers and medical radiography
1. Digital computers
2. Analog computers

Texts and References

Glasser and others, *Physical Foundations of Radiology*

Johns, *The Physics of Radiology*

Ridgway and Thum, *The Physics of Medical Radiography*

Selman, *The Fundamentals of X-ray and Radium Physics*

Visual Aids

Motion Pictures:

The Cathode Ray Tube: How it Works. 15 min., 16mm., sd., b & w. Pennsylvania State University, Audio-Visual Aids Library, University Park, Pennsylvania.
Summary: Construction and function of each part. How the visual image is produced.

Electric Current, Learning About. 8 min., 16 mm., sd., b & w. Indiana University, Audio-Visual Center, Bloomington, Indiana.
Summary: Describes the characteristics and dangers of electric current. Circuits, conductors, insulators, fuses, and switches are explained both in animation and in simple demonstrations.

Electricity. 10 min., 16 mm., sd., b & w. Pennsylvania State University, Audio-Visual Aids Library, University Park, Pennsylvania.
Summary: How electricity is generated and what it does for us. Turbines, generators, motors, open and closed circuits, etc.

Electricity, Principles of. 20 min., 16 mm., sd., color. Pennsylvania State University, Audio-Visual Aids Library, University Park, Pennsylvania.

Summary: Structure of matter, action of electrons within an atom by use of conventional symbols, principles of current flow, volt, ohm, ampere, magnetism and magnetic fields defined.

Generator, Principles of the. 10 min., 16 mm., sd., b & w. Indiana University, Audio-Visual Center, Bloomington, Indiana.

Summary: Uses animation to explain the elementary principles of electro-magnetic induction. These principles are then related to the operation of the generator which supplies electric current to homes and factories.

Matter and Energy. 10 min.; 16 mm., sd., color. Indiana University, Audio-Visual Center, Bloomington, Indiana.

Summary: Basic concepts that everything in the universe is composed of matter and affected by energy. Elements, compounds and mixtures defined. Brief explanation of atomic energy.

Transparencies:

Teaching Aids in Radiologic Physics. General Aniline and Film Corporation, 140 West 51st Street, New York, N.Y. 10020.

Other:

X-ray Machine Simulator With Oscilloscope. Heath Company, Benton Harbor, Michigan.

MATHEMATICS AND SCIENCE COURSES

Technical Mathematics I

HOURS PER WEEK

Class, 3

Course Description

This course is designed to teach the student basic manipulative techniques in algebra and trigonometry with emphasis on those skills necessary for technical programs. The course content includes standard notation and use of slide rule, including multiplication, division, powers, roots. The course also includes operation of algebraic expressions and fractions, manipulation of physical units appropriate to engineering applications, algebraic solution to linear equations in one unknown, cartesian coordinate plane, slope of a straight line, determining linear equations from given conditions, and graphical solution of two or more linear equations.

Major Divisions

		Class Hours
I.	Slide Rule	4
II.	Fundamentals	6
III.	Functions and Graphs	5
IV.	Trigonometric Functions	5
V.	Linear Equations and Determinants	6
VI.	Factoring and Fractions	6
VII.	Quadratic Equations	8
VIII.	Trigonometric Functions of any Angle or Number	8
	Total	48

Units of Instruction

- I. Slide Rule
  - A. Reading numbers
  - B. Multiplication and division
  - C. Squaring numbers
- II. Fundamentals
  - A. Real number system
  - B. Exponentials and radicals
  - C. Addition, subtraction, multiplication, and division of algebraic expressions
  - D. Equations and formulas
- III. Functions and Graphs
  - A. Functions
  - B. Rectangular coordinate system
  - C. Graphs of functions
  - D. Zeros of functions
- IV. Trigonometric Functions
  - A. Angles
  - B. Definition of trigonometric functions
  - C. Values of the trigonometric functions
  - D. Right triangle problems
- V. Linear Equations and Determinants
  Solving two linear equations by sketching, algebraic methods and by determinants
- VI. Factoring and Fractions
  - A. Special products
  - B. Factoring
  - C. Simplifying fractions
  - D. Multiplication and division of fractions
  - E. Addition and subtraction of fractions
- VII. Quadratic Equations
  - A. Solution of quadratic equations by factoring
  - B. Solution of quadratic equations by completing the square
  - C. The quadratic formula and its uses
- VIII. Trigonometric Functions of any Angle or Number
  - A. Trigonometric functions in the four quadrants
  - B. Radians
  - C. Arc length, sector area and linear velocity
  - D. Trigonometric functions of any angle

Texts and References

Washington, *Basic Technical Mathematics*

Human Anatomy and Physiology I

HOURS PER WEEK

Class, 2; Laboratory, 2

Course Description

	Class Hours	*Lab Hours*
I. General Organization of the Human Body	8	4
II. Structure of the Body	10	18
III. Coordination	14	10
Total	32	32

Units of Instruction

- I. General Organization of the Human Body
  - A. Body planes
  - B. Body cavities and contents
  - C. Examples of homeostasis
  - D. Gross anatomy and brief physiology of the ten organ systems of the human
  - E. The animal cell
    - 1. Composition of protoplasm
    - 2. Cytoplasmic structures and their functions
      - a. Cell membrane
      - b. Endoplasmic reticulum
      - c. Ribosomes
      - d. Lysosomes
      - e. Mitochondria
      - f. Vacuoles
      - g. Centrosomes
      - h. Golgi's apparatus
    - 3. Nucleoplasmic structures and their functions
    - 4. Structure and function of DNA
    - 5. Mitosis, meiosis
    - 6. Cell respiration
      - a. Glycolysis
      - b. Gluconeogenesis
      - c. Glycogenolysis
      - d. Glycogenesis
    - 7. How substances get into the cell
      - a. Diffusion
      - b. Osmosis
      - c. Active transport
      - d. Pinocytosis
      - e. Phagocytosis
      - f. Filtration
  - F. Histology
    - 1. Classification, function, and location of tissue
      - a. Epithelium
      - b. Connective
      - c. Muscle
      - d. Nerve
      - e. Blood
    - 2. All types of cells under the above tissue classifications
- II. Structure of the Body
  - A. Skin
    - 1. Physiological anatomy of the layers
    - 2. Sunburn
    - 3. Heredity of pigmentation
    - 4. Appendages
      - a. Nails
      - b. Hair
      - c. Glands, sweat and sebaceous
      - d. Nerve receptors
    - 5. Abnormal growths
    - 6. Wound healing
  - B. Skeletal system
    - 1. Functions of bones
    - 2. Types of bones
    - 3. Chemistry of bone
      - a. Composition of bone
        - (1) With age change
        - (2) In dietary deficiencies
      - b. Strontium-90
    - 4. Bone formation
      - a. Histology
        - (1) Osteocyte, osteoblasts, osteoclasts
        - (2) Haversian system
      - b. Intramembranous ossification
      - c. Endochondral ossification
    - 5. Dietary requirements
    - 6. Diseases, etc.
      - a. Rickets
      - b. Osteoporosis
      - c. Repair of fractures
    - 7. Bone marrow and antibodies
  - C. Articulation
    - 1. Joint classification—movements
      - a. Synarthrosis
      - b. Amphiarthrosis
      - c. Diarthrosis
        - (1) Types of movement in each type of joint
        - (2) Anatomy of a joint
    - 2. Diseases of joints
      - a. Arthritis
      - b. Bursitis
      - c. Fibrositis
      - d. Rheumatic fever
      - e. Tenosynovitis

- D. Muscular system
  - 1. Functions of muscles
  - 2. Muscle types
    - a. Involuntary
      - (1) Histology and physiology
      - (2) Location
  - 3. Principles of muscle contraction
    - a. The myoneural junction
    - b. Excitation of the myofibril
    - c. Origin, insertions, actions
    - d. Levers
    - e. Muscle tone
    - f. Neural route for muscle stimulation
    - g. Motor unit ratios and contraction
  - 4. Strength
    - a. Hypertrophy, atrophy, hyperplasia
    - b. Blood supply changes
    - c. Isotonic, isometric contractions
  - 5. Chemistry of contraction
    - a. ATP, creatine phosphate, lactic acid, Krebs' cycle
    - b. Oxygen department
  - 6. Muscular system disorders
    - a. Contracture
    - b. Tetany
    - c. Muscular dystrophy
    - d. Myasthenia gravis
    - e. Cramps
- III. Coordination
  - A. The nervous system
    - 1. Divisions of the nervous system
    - 2. Basic functions of the nervous system
    - 3. Histology
      - a. Neuron (unipolar, bipolar, multipolar, sensory, association, motor)
      - b. Neuroglia
      - c. Spinal cord
    - 4. The nerve impulse
      - a. Threshold, subthreshold stimuli
      - b. Conduction through myelinated—nonmyelinated fibers
    - 5. The synapse
      - a. Chemical transmitters
      - b. Cholinesterase
      - c. Drug effects
    - 6. Reflex
      - a. Anatomy
      - b. Types (pupil, knee, pain, hormonal, etc.)
  - B. Central nervous system
    - 1. Meninges
      - a. Function and location
      - b. Disease
    - 2. Ventricles
      - a. Function and location
      - b. Cerebrospinal fluid
        - (1) Function
        - (2) Production, absorption
        - (3) Composition
        - (4) Hydrocephalus
    - 3. Brain—telencephalon
      - a. Anatomy
        - (1) Lobes
        - (2) Sulci
        - (3) Internal structures
      - b. Physiology
      - c. Dysfunction
    - 4. Brain—diencephalon
      - a. Anatomy and physiology
        - (1) Thalamus
        - (2) Hypothalamus
        - (3) Hypophysis
        - (4) Optic chiasma
      - b. Dysfunction
    - 5. Brain—mesencephalon
      - a. Anatomy and physiology
        - (1) Quadrigeminate bodies
        - (2) Cerebral peduncles
        - (3) Aqueduct of Sylvius
      - b. Dysfunction
    - 6. Brain—rhombencephalon
      - a. Anatomy and physiology
        - (1) Cerebellum
        - (2) Pons
          - (a) Medulla oblongata
          - (b) Reticular formation
      - b. Dysfunction
  - C. Blood supply to the brain
  - D. Injuries to skull, brain
  - E. Cranial nerves and their innervation
  - F. Spinal cord
    - 1. Functions (review)
    - 2. Anatomy (review)
    - 3. Location of selected nerve tracts and their functions
  - G. Spinal nerves, peripheral
    - 1. Histology
    - 2. Anatomy
      - a. Innervation of selected peripheral nerves
      - b. Regeneration of peripheral nerves
    - 3. Definition of a plexus
  - H. Autonomic nervous system
    - 1. General physiology
    - 2. Specific anatomy and physiology of both divisions

   3. Neural conductors
   4. Synergistic and antagonistic drugs

I. Special senses
   1. Receptor specificity
   2. Fatigue of receptors
   3. Vision
      a. Anatomy of the eye
      b. Physiology of vision
      c. Disorders of the eye
   4. Hearing, balance
      a. Anatomy of the ear
      b. Physiology of hearing and balance
      c. Disorders of hearing and balance
   5. Taste
   6. Smell
   7. Kinesthetic
   8. Pain (selected readings from Scientific American)

Laboratory (32 hours)

Laboratory work in this course is devoted to the study of the disarticulated skeleton. The following outline encompasses the system of approach used. Practical examinations covering each system is the method of testing the student's ability.

A. The tissues
   1. Epithelial tissues
   2. Loose connective tissues
   3. Dense connective tissues
      a. Cartilage
      b. Bone

B. Introduction to the bones
   1. The skull
      a. Face
      b. Cranium
      c. Floor
      d. Jaws
   2. Hyoid
   3. Vertebral column
   4. Ribs and sternum

C. Introduction to the limbs
   1. Pectoral girdle
   2. Upper limbs
   3. Pelvic girdle
   4. Lower limbs

D. Introduction to the joints and muscles
   1. Pectoral muscles
   2. Shoulder, hip, and limb muscles

E. The central nervous system
   1. Study of the brain and spinal cord from specimens
   2. Study of the brain and spinal cord from models
   3. Dissection of the brachial plexus
   4. Dissection of the sacrolumbar plexus

F. The autonomic nervous system
   1. The ear
   2. The eye

Texts and References

Allen, *The Microscope*
Anthony, *Textbook of Anatomy and Physiology*
Chaffee and Greisheimer, *Basic Physiology and Anatomy*
Decoursey, *The Human Organism*
Dienhart, *Basic Human Anatomy and Physiology*
Gage, *The Microscope*
Greisheimer, *Physiology and Anatomy*
Guyton, *Textbook of Medical Physiology*
Hamm and Leeson, *Histology*
Jacob and Francone, *Structure and Function in Man*
Jacobi, *Textbook of Anatomy and Physiology in Radiologic Technology*
Kimber and others, *Anatomy and Physiology*
King and Showers, *Human Anatomy and Physiology*
Mallett, *A Handbook of Anatomy and Physiology for Student X-ray Technicians*
Needham, *Practical Use of the Microscope*
Reith and others, *Anatomy and Physiology*
Swanson, *The Cell*

Visual Aids

Motion Pictures:

The Human Body: Skeleton. 11 min., color. Coronet Instructional Films, Coronet Building, 65 East Southwater Street, Chicago, Illinois.
Summary: Explains the most important aspects of the human skeleton. Through cinefluorography, the audience gains an overview of the skeletal structure, the complexity of the system, and how the skeleton protects, moves, and supports the body.

The Skeleton. 13 min., 16 mm., sd., b & w. Encyclopedia Britannica Films, Inc., 1150 Wilmette Avenue, Wilmette, Illinois.
Summary: Describes in detail the formation, growth, development, and function of the human skeleton. Microphotography and animated drawings reveal what bones consist of and how they grow. Dramatic motion picture x-ray photo-

graphy shows how joints move. Attention is called to the role of proper food and posture in correct bone development.

Filmstrips:

Anatomy and Physiology: The Skeletal System. 35 mm., 58 frames, sd., color. U.S. Dept. of the Army.

Summary: Describes the anatomy and physiology of the skeletal system, including functions of bones, characteristics and functions of the axial skeleton and appendicular skeleton. For medical profession and allied scientific groups.

Human Anatomy and Physiology II

HOURS PER WEEK

Class, 2; Laboratory, 2

Course Description

This course is a study of the structural and functional approach to the digestive, respiratory, endocrine and reproductive systems. A survey of the embryology of the major body system.

Major Divisions

	Class Hours	*Lab Hours*
I. Circulatory System......	6	10
II. Respiratory System......	4	10
III. Metabolism............	6	2
IV. Urinary System.	5	6
V. Chemical Coordination	6	2
VI. Reproductive System	5	2
Total	32	32

Units of Instruction

- I. Circulatory System
  - A. Types of fluids
  - B. Fluid compartments
  - C. Blood
    - 1. Functions
    - 2. Composition
      - a. Red blood corpuscle
        - (1) Numbers
        - (2) Formation
        - (3) Destruction
        - (4) Regulation of RBC numbers
        - (5) Functions
        - (6) Anemias
        - (7) Polycythemia
      - b. White blood cell
        - (1) Numbers and types
        - (2) Formation
        - (3) Destruction
        - (4) Function of each type
        - (5) Effects of radiation
        - (6) Leukocytosis
        - (7) Leukopenia
      - c. Platelets
        - (1) Number
        - (2) Function
      - d. Plasma
        - (1) Composition
          - (a) Types of protein
          - (b) Electrolytes
          - (c) Non-electrolytes
        - (2) Requirements of plasma substitutes
        - (3) How the plasma is studied
  - D. Blood coagulation
    - 1. Extrinsic method
    - 2. Intrinsic method
    - 3. Factors that alter coagulation and disease
    - 4. Anticoagulants
    - 5. Procoagulants
  - E. Blood type, ABO, Rh
    - 1. Genetic inheritance patterns
    - 2. Antigen—antibodies
    - 3. Donors—recipients
    - 4. Mismatching complications
    - 5. Marriage and Rh blood types
  - F. Circulation pattern
  - G. Histology of arteries, veins, and capillaries
  - H. The heart
    - 1. Anatomy of vessels, valves, and chambers
    - 2. Plan of blood flow in cardio-pulmonary system
    - 3. Coronary circulation
    - 4. Excitation of heart
    - 5. ECG
      - a. Normal voltage
      - b. Normal times
      - c. Abnormal patterns and their interpretation
    - 6. Heart attacks
    - 7. Circulation through heart-lung machine
  - I. Cardiac output
    - 1. Normal cardiac output
    - 2. Factors altering cardiac output
  - J. Blood pressure
    - 1. Factors altering blood pressure
    - 2. Neural control of blood pressure
      - a. Pressure
      - b. Chemical
    - 3. Results of decreased cardiac output
    - 4. Shock
  - K. Lymphatic system
    - 1. Function of system and organs
    - 2. Circulatory plan
    - 3. Composition of lymph
    - 4. Diseases, edema, etc.
- II. Respiratory System
  - A. Anatomy of the respiratory system
  - B. Ventilation
    - 1. Muscles
    - 2. Air volumes
    - 3. Dead air space

- C. Diffusion and transport of gases
  - 1. Dalton's Law
  - 2. Partial pressure of O_2 and CO_2 in artery, capillary, tissues, and veins
  - 3. Hemoglobin and O_2
  - 4. Methods of CO_2 transport
  - 5. Effects of altitude and deep-sea diving on partial pressures of gases
  - 6. Oxygen dissociation curve
- D. Control of ventilation
  - 1. Neural centers and reflexes
  - 2. Factors increasing and decreasing ventilation
- E. Selected diseases of respiratory system

III. Metabolism

- A. Physiological anatomy of the digestive system
  - 1. Mouth
    - a. Teeth
    - b. Tongue
    - c. Salivary glands and their secretions
    - d. Function
  - 2. Esophagus
  - 3. Stomach
    - a. Curvatures
    - b. Pyloric fundus, cardiac region
    - c. Gastric glands and their secretions
    - d. Histology
    - e. Function
  - 4. Small intestine
    - a. Divisions
    - b. Secretions
    - c. Histology
    - d. Functions
  - 5. Large intestine
    - a. Divisions
    - b. Secretions
    - c. Functions
  - 6. Rectum
  - 7. Liver
    - a. Gross anatomy
    - b. Histology
    - c. Functions
    - d. Secretions
  - 8. Pancreas
    - a. Gross anatomy
    - b. Histology
    - c. Functions
    - d. Secretions (enzymatic and hormonal)
- B. Hepatic portal system
- C. Digestive hormones
- D. Biochemistry of foods
  - 1. Carbohydrate
  - 2. Protein
  - 3. Fat
  - 4. Vitamins
  - 5. Minerals
- E. Digestion and metabolism of the three major food types
  - 1. Enzymatic catabolism
  - 2. Transport into circulatory system
  - 3. Use in the liver
  - 4. Use by the cell
  - 5. Excretion of waste products
- F. Hormones involved in the metabolism of food
- G. Chemical equations summarizing the use of oxygen and carbohydrates for energy

IV. Urinary System

- A. Gross anatomy and physiology of the urinary system
- B. Anatomy of the nephron
- C. Effect of hydrostatic and osmotic pressures on the filtration pressure
- D. Composition of filtrate
- E. Substances selectively reabsorbed
- F. Aldosterone and A.D.H.
- G. Physical and chemical characteristics of urine
- H. Micturation
- I. Pathology

V. Chemical Coordination

- A. Endocrine glands and their location
- B. Principles of endocrinology
  - 1. Hormone action
  - 2. Types of hormones
  - 3. Feed-back

VI. Reproduction

- A. The male
  - 1. Physiological anatomy
  - 2. Histology of testicle
  - 3. Composition of semen
  - 4. Male hormones and their actions
    - a. Testicular
    - b. Pituitary
  - 5. Male fertility
- B. The female
  - 1. Physiological anatomy
  - 2. Histology of ovary
  - 3. Hormonal control of the ovulatory cycle and their actions
    - a. Ovarian
    - b. Pituitary
  - 4. Female fertility
  - 5. Anatomy and physiology of the mammary gland

- C. Pregnancy
    - 1. Fertilization
    - 2. Implantation
    - 3. Hormones of pregnancy
    - 4. Pituitary and gonadal control
    - 5. Mammary changes
    - 6. Important events of pregnancy
    - 7. Parturition
        - a. Hormonal control
        - b. Events
    - 8. Lactation
- D. Basic embryology (in brief)

Laboratory (32 hours)

Laboratory work in this course is devoted to dissection of a cat and microscopic histology. The following outline encompasses the system of approach used. Practical examinations covering each system is the method of testing the student's ability.

- A. Introduction to the blood
- B. Dissection of sheep's heart
- C. The circulatory system
    - 1. The arteries
    - 2. The veins
    - 3. The lymphatic system
- D. The respiratory system
    - 1. Histology of the respiratory organs
    - 2. Dissection of the respiratory system
- E. The digestive system
    - 1. Histology of the digestive organs
    - 2. Dissection of the digestive system
- F. The excretory system
    - 1. Histology of the excretory organs
    - 2. Dissection of the excretory system
- G. The reproductive system
    - 1. Histology of the reproductive organs
        - a. The male
        - b. The female
    - 2. Dissection of the reproductive system
        - a. The male
        - b. The female
- H. The endocrine system
    - 1. Histology of the endocrine organs
    - 2. Dissection of the endocrine system

Texts and References

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Summary: Describes in detail the formation, growth, development, and function of the human skeleton. Microphotography and animated drawings reveal what bones consist of and how they grow. Dramatic motion picture x-ray photography shows how joints move. Attention is called to the role of proper food and posture in correct bone development.

Filmstrips:

Anatomy and Physiology: The Skeletal System. 35 mm., 58 frames, sd., color. U.S. Dept. of the Army.

Summary: Describes the anatomy and physiology of the skeletal system, including functions of bones, characteristics and functions of various types of bones and characteristics and functions of the axial skeleton and appendicular skeleton. For medical profession and allied scientific groups.

Physical Science I

HOURS PER WEEK

Class, 2; Laboratory, 2

Course Description

This course is a lecture and laboratory approach to the basic sciences of physics and chemistry. Insofar as possible, the content and applications are oriented towards the life sciences.

Major Divisions

	Class Hours	Lab Hours
I. Measurement	2	2
II. Simple Machines	2	4
III. Relationship of Matter and Energy	4	4
IV. Electrical energy	2	8
V. Atomic Nature of Matter	3	2
VI. Periodic Table	2	
VII. Atomic Structure and Bonding	3	
VIII. Solutions	2	4
IX. Chemical Reactions	4	4
X. Organic Chemistry	4	4
XI. Nuclear Reactions	4	
Total	32	32

Units of Instruction

- I. Measurement
  - A. Accuracy
  - B. Metric System
  - C. Temperature
  - D. Forces
- II. Simple Machines
  - A. Levers, inclined planes, pulleys
  - B. Mechanical advantage
- III. Relationship of Matter and Energy
  - A. Particle concept of matter
  - B. Pressure
  - C. Heat and mechanical energy
  - D. Ideal gases
  - E. Kinetic theory
  - F. Avogadro's hypothesis
- IV. Electrical Energy
  - A. Static charges
  - B. Inverse square law
  - C. Magnetic influence
  - D. Electromagnetic radiation
  - E. Electrons as particles of electricity
- V. Atomic Nature of Matter
  - A. Chemical changes
  - B. Composition laws
  - C. Dalton's Atomic Theory
  - D. Symbols
  - E. Gram molecular weights
  - F. Atomic weights
- VI. Periodic Table
  - A. Mendeleev and periodic law
  - B. Noble gases
  - C. Properties of families and use of table
- VII. Atomic Structure and Bonding
  - A. Electrical nature
  - B. Electron "shells"
  - D. Ionization
  - E. Covalent bonding
  - F. Polar covalent bonds
- VIII. Solutions
  - A. Ionic solids
  - B. Electrolytes in polar solvents
- IX. Chemical Reactions
  - A. Acids and bases
  - B. Salts
  - C. Equilibrium
- X. Organic Chemistry
  - A. Hydrocarbons
  - B. Isomerism
  - C. Unsaturated compounds
  - D. Functional groups
  - E. Some biologically important compounds
- XI. Nuclear Reactions
  - A. Isotopes
  - B. Natural radioactivity
  - C. Artificial nuclear change
  - D. Energy

Laboratory (32 hours)

Laboratory work in this course is devoted to experiments covering appropriate concepts in physics and chemistry, problem sessions, and demonstrations. Math review and metric measurements, simple machine experiments, specific heat and gases, series of reactions with copper, freezing point depression, equilibrium films and experiments, molecular models, and saponification or esterification experiments are intended laboratory procedures.

Texts and References

Miller, *Chemistry*
Rosen and others, *Concepts in Physical Science*
Tilley and Thum, *College Physics: A Text with Applications to the Life Sciences*

GENERAL COURSES

Business Organization and Management

HOURS PER WEEK

Class, 3

Course Description

This course is a study of basic concepts, functions, and the management process of planning, organization, staffing, direction, and control as they relate to modern business operations and problems.

Major Divisions

		Class Hours
I.	The Basis of Management	3
II.	Planning and Decision Making	6
III.	Organization	6
IV.	Staffing	6
V.	Nature of Direction	9
VI.	Budgeting and Purchasing	12
VII.	Departmental Administration	6
	Total	48

Units of Instruction

- I. The Basis of Management
  - A. Science and management
  - B. Principles of casual relationships
  - C. The need for principles of management
  - D. Early contributions to management principles
  - E. Management theory
  - F. Managerial functions
- II. Planning and Decision Making
  - A. The nature and purpose of planning
    - 1. Efficiency of plans
    - 2. Types of plans
    - 3. Objectives
    - 4. Policies
  - B. Steps in planning
    - 1. Being aware of opportunity
    - 2. Establishing objectives
    - 3. Determining alternative courses
    - 4. The planning process; rational approach
  - C. The planning period
  - D. Flexibility in planning
  - E. Decision making
    - 1. Developing alternatives
    - 2. The process of evaluation
    - 3. Basis for selection among alternatives
      - a. Experimentation
      - b. Research
    - 4. Politics of decision making
- III. Organization
  - A. Nature and purpose of organization
    - 1. Formal and informal organization
    - 2. Organizing as a process
      - a. By logic
      - b. In practice
  - B. Span of management
    - 1. Departmentation
    - 2. Factors determining frequency and severity of relationships
      - a. Subordinate training
      - b. Delegation of authority
      - c. Planning
      - d. Rate of change
      - e. Use of objectives
  - C. Basic departmentation
    - 1. Departmentation by simple numbers
    - 2. Departmentation by enterprise function
    - 3. Departmentation by territory
    - 4. Mixing departmentation
  - D. The assignment of activities
    - 1. Three issues in assigning activities
      - a. Recognition of activities
      - b. Need for combining activities
      - c. Need for guides
    - 2. Assignment by similarity of activity
    - 3. Guides for assignment by intimate association
    - 4. Application of the guides for assignment of activity
- IV. Staffing
  - A. Line and staff authority relationships
    - 1. Line and staff concepts
    - 2. Relationship of departmentation
    - 3. Specialization of managerial functions
  - B. Development of the staff concept
  - C. Staff relationships
    - 1. Functional authority
    - 2. Functional authority delegation
    - 3. Unity of command
  - D. Line and staff in practice
  - E. Limitations of using staff
  - F. Development of service departments

- G. Decentralization of authority
- H. Making organization effective

V. Nature of Direction
- A. Manager's relation to subordinates
- B. Two important principles
  - 1. Harmony of objective
  - 2. Unity of command
- C. Orientation
- D. Issuing orders
  - 1. Definition of an order
  - 2. Techniques
- E. Delegation as a means of direction
- F. Motivation
  - 1. Necessity for motivation
  - 2. What work is
  - 3. What good motivation does
    - a. Satisfies needs
    - b. Saturates basic needs
    - c. Releases work capacity
  - 4. What a sound system must be
    - a. Productive
    - b. Competitive
    - c. Comprehensive
    - d. Flexible
  - 5. Discipline and morals
- G. Communication
  - 1. Purpose
  - 2. Barriers
  - 3. Principles of communication
  - 4. Techniques
  - 5. Crosswise communications
  - 6. Written versus oral messages
- H. Leadership
  - 1. Difficulties in teaching leadership
  - 2. The environment
  - 3. Cultivated attitudes of leaders
    - a. Empathy
    - b. Objectivity
    - c. Self knowledge
  - 4. Use of informal organization
  - 5. Dynamics of change
  - 6. Techniques
    - a. Confidence building
    - b. Zeal building

VI. Budgeting and Purchasing
- A. Costs in a department of radiology
  - 1. Operating expenses
    - a. Monetary recompense to radiologist
    - b. Salaries
    - c. Supplies
    - d. Equipment
      - (1) Leasing procedures
      - (2) Purchasing
    - e. Maintenance
      - (1) Service contract
      - (2) Non-contract service
      - (3) Preventative maintenance
  - 2. Non-operating or indirect costs
    - a. Insurance
    - b. Interest
    - c. Rentals
    - d. Taxes
    - e. Depreciation
    - f. Replacements
- B. Budgeting
  - 1. Defining a budget
  - 2. Purpose of a budget
  - 3. Budget considerations
    - a. Time element
    - b. Revision
  - 4. Budget calculation
    - a. Anticipated income
    - b. Estimated costs
    - c. Miscellaneous
- C. Purchasing
  - 1. Decentralized
    - a. Authority of purchasing placed in hands of several individuals
    - b. Purchasing done by buyer in his own field
    - c. Advantages
    - d. Disadvantages
  - 2. Centralized control
    - a. Similarities with decentralized system
    - b. Department heads allowed to purchase under administrative control
  - 3. Centralized purchasing
    - a. All purchasing under direct supervision of purchasing agent
    - b. Necessity for good communication with department heads
    - c. Advantages
    - d. Disadvantages

VII. Departmental Administration
- A. The charter and corporate organization of the hospital
  - 1. The charter
    - a. Purposes of incorporation
    - b. Definition and powers of a corporation
  - 2. Corporate organization of the hospital
    - a. Board of control
    - b. Functions of the board
    - c. Responsibilities of the board
- B. The hospital
  - 1. Definition

a. Importance of definition
b. Derivation of name
c. Legal definition
d. Basic classifications

2. Objectives
 a. Immediate objectives
 b. Ultimate objectives

C. Planning a department of radiology
1. Location of department
 a. Therapy and nuclear medicine
 b. Close proximity to surgical department
 c. On ground floor of a pediatric hospital

2. Size of department
 a. Able to serve present and future needs
 b. Large enough to permit efficient functioning
 c. Adequate storage space

3. Department construction
 a. Darkroom(s) in center of department or easily accessible from exposure rooms
 b. Location of waiting rooms and lavatories
 c. Offices for radiologists, supervisor, etc.
 d. Clerical area
 e. Locker rooms and lounge for personnel
 f. Wide corridors and doors
 g. Proper communication systems
 h. Proper electrical and plumbing systems
 i. Special wiring for high techniques
 j. Adequate protection considerations

Texts and References

Haimann, *Management in The Modern Organization*
Scott, *Planning Guide for Radiologic Installations*
Svenson, *Management Experience*

Communication Skills I

HOURS PER WEEK

Class, 3

Course Description

This course is designed for students who intend to complete only two years of college. The purpose of the course is to help the student read more intelligently and write more clearly. Class work distinguishes among the purposes of ordinary writing, guides the students in organizing their ideas, and helps them to develop and present their ideas with clarity and coherence. Logical reasoning and unity are emphasized, but unnecessary technical terminology is avoided. Students will be required to read and report on two outside books and to write regularly both in and out of class.

Major Divisions

	Class Hours
I. Communication	12
II. Sentence Structure	9
III. Written Expression	12
IV. Improving Reading Efficiency	15
Total	48

Units of Instruction

- I. Communication
  - A. Proficiency in the art of communication
  - B. Why communication is an essential skill
    - 1. Statements and facts
    - 2. Expression of ideas
    - 3. Technical reporting
      - a. Formal
      - b. Informal
- II. Sentence Structure
  - A. Sentence patterns
  - B. Kinds of sentences
  - C. Effective sentences
    - 1. Unity
    - 2. Variety
    - 3. Emphasis
    - 4. Coherence
    - 5. Diction
  - D. Phrases
  - E. Clauses
- III. Written Expression
  - A. What is a good paragraph?
  - B. Characteristics of a good paragraph
    - 1. Unity
    - 2. Completeness
    - 3. Coherence
    - 4. Emphasis
  - C. Unity
    - 1. Main idea or topic sentence
    - 2. Positions of main ideas
    - 3. Inferred main idea
- IV. Improving Reading Efficiency
  - A. Learning about reading
    - 1. Purpose and difficulty
    - 2. Flexibility
    - 3. Characteristics of a good reader
  - B. Building a vocabulary
    - 1. Types of vocabulary
    - 2. Ways of building a vocabulary

Texts and References

Casmier and Bobrow. *Focus: Photograph for Composition*

Cowan and McPherson. *Plain English Rhetoric and Reader* and *Exercising Plain English*

————————. *Plain English Please*

Communication Skills II

HOURS PER WEEK

Class, 3

Course Description

This course is designed to apply the basic communication skills to practical uses, such as various kinds of letter writing, data gathering, report writing, speaking, and learning to read critically in those media which affect the student on his job, as a consumer, and as a citizen.

Major Divisions

	Class Hours
I. Introduction to Course Writing	9
II. Report Writing	12
III. Oral Report Presentation	15
IV. Reading and Discussion	12
Total	48

Units of Instruction

I. Introduction to Course Writing
  A. The job application letter
    1. Purpose
    2. Style
    3. Organization
  B. Job application form
    1. Filling out application form
    2. Relevant data
  C. Letter writing
    1. Variety
    2. Purpose
    3. Content
    4. Inclusion of necessary information
II. Report Writing
  A. Data-gathering techniques
  B. Organizing methods
  C. Using the library
    1. Source books
    2. Use of materials
III. Oral Report Presentation
  A. Person-to-person expression of ideas and thoughts
  B. Verbal reporting
IV. Reading and Discussion
  A. Editorials
  B. News
  C. Propaganda
  D. Comparison of news stories from various sources
  E. Advertising
    1. Language
    2. Methods

Texts and References

Cowan and McPherson. *Plain English Rhetoric and Reader* and *Exercising Plain English*

____________. *Plain English Please*

General Psychology I

HOURS PER WEEK

Class. 3

Course Description

This course is a bio-social scientific study of physiological, mental, and emotional development of normal human behavior. It includes a short history of modern psychology as well as introductory statistical concepts and is a prerequisite for all other courses in psychology.

Major Divisions

	Class Hours
I. History and Scope of Psychology	3
II. Psychology as a Science	3
III. Developmental Psychology	9
IV. Motivation and Drives	6
V. Emotion	6
VI. The Psychology of the Individual	9
VII. Deviance and Pathology	6
VIII. The Therapeutic Modification of Behavior	6
Total	48

Units of Instruction

- I. History and Scope of Psychology
  - A. Origins of modern psychology
    - 1. Physiology
    - 2. Phrenology
    - 3. Hypnotism
    - 4. Philosophy
      - a. Dualism
      - b. Monism
  - B. History of psychology
    - 1. Structuralism
    - 2. Behaviorism
    - 3. Gestalt
    - 4. Psychoanalysis
  - C. What psychologists do
    - 1. Experimental
    - 2. Clinical
    - 3. Developmental
  - D. Goals of psychology
    - 1. Description
    - 2. Explanation
    - 3. Prediction
    - 4. Control
- II. Psychology As a Science
  - A. Scientific characteristics of psychology
  - B. Assumptions of the scientific approach
    - 1. Order
    - 2. Determinism
    - 3. Discoverability
  - C. Methods of psychology
    - 1. Field study
    - 2. Life history
    - 3. Survey
    - 4. Experimental
      - a. Variables
      - b. Control
      - c. Generalization
  - D. Psychological observations
    - 1. Standard methods
    - 2. Unobtrusive measures
  - E. Possible research errors
    - 1. Errors from the respondent
    - 2. Errors from the investigator
    - 3. Sampling errors
  - F. Introduction to statistics
    - 1. Scales of measurement
      - a. Nominal
      - b. Ordinal
      - c. Interval
      - d. Ratio
    - 2. Elementary statistics
      - a. Mean
      - b. Median
      - c. Mode
      - d. Variability
      - e. Correlation
      - f. Probability
- III. Developmental Psychology
  - A. Heredity vs. environment
    - 1. Twin research
    - 2. Instinct
    - 3. Maturation
  - B. Physical development
    - 1. Nutritional and metabolic deficiences
    - 2. Growth of the brain
  - C. Motor development
    - 1. Prenatal motor activity
    - 2. The postnatal sequence of motor development
  - D. Perceptual development
    - 1. Kinesthetic
    - 2. Olfactory
    - 3. Gustatory
    - 4. Audition
    - 5. Vision

  - E. Language development
    - 1. Errors
    - 2. Patterned speech
  - F. Cognitive development—Piaget
    - 1. Sensorimotor stage
    - 2. Symbolic operational stage
    - 3. Formal operations stage
- IV. Motivation and Drives
  - A. Measuring drive
    - 1. Physical measures
    - 2. Psychological measures
  - B. Physical drives
    - 1. Hunger
    - 2. Thirst
    - 3. Sex
    - 4. Maternal
    - 5. Pain
    - 6. Contact comfort
  - C. Psychological drives
    - 1. Curiosity
    - 2. Activity
    - 3. Aggression
    - 4. Symbolic rewards
  - D. Maslow's Theory ot Motivation
- V. Emotion
  - A. Bodily changes in emotion
    - 1. Galvanic skin response
    - 2. Blood distribution
    - 3. Heart rate
    - 4. Respiration
    - 5. Pupillary
    - 6. Salivary
    - 7. Pilomotor
    - 8. Gastrointestinal mobility
  - B. James-Lange vs. Cannon
  - C. Centers of emotion
    - 1. Limbic system
    - 2. Sympathetic vs. parasympathetic
    - 3. Prefrontal area of brain
    - 4. Pyriform cortex
  - D. Psychosomatic disorder
  - E. General adaptation syndrome
    - 1. Alarm reaction
    - 2. Stage of resistance
    - 3. Stage of exhaustion
  - F. How emotions develop
    - 1. Watson—Little Albert
    - 2. Conditioning and emotion
  - G. Emotional behavior during adolescence
  - H. Emotional behavior in marriage
  - I. Alcoholism and drug addiction
- VI. The Psychology of the Individual
  - A. Test and measurement
    - 1. Reliability
    - 2. Validity
    - 3. Standardization
    - 4. Rating scale
    - 5. Factor analysis
  - B. Intelligence tests
    - 1. Spearman's Two-factor Theory
    - 2. Thurstone's Primary Mental Abilities
    - 3. Binet-Simon
    - 4. Wechsler
  - C. Personality theories
    - 1. Sheldon
      - a. Components of physique
        - (1) Endomorphy
        - (2) Mesomorphy
        - (3) Ectomorphy
      - b. Dimensions of temperament
        - (1) Visceratonia
        - (2) Somatatonia
        - (3) Cerebrotonia
      - c. Stereotypical extension
        - (1) Face
        - (2) Voice
        - (3) Graphology
    - 2. Freud
      - a. Id. ego and superego
      - b. Anal. oral. phallic and genital
    - 3. Dollard and Miller
    - 4. Adler
    - 5. Jung
    - 6. Fromm
  - D. Projective techniques
    - 1. Rorschach
    - 2. T.A.T.
    - 3. Sentence completion
- VII. Deviance and Pathology
  - A. Reactions to frustration
    - 1. Attack
    - 2. Withdrawal
    - 3. Compromise
  - B. Defense mechanisms
    - 1. Displaced aggression
    - 2. Repression
    - 3. Fantasy
    - 4. Regression
    - 5. Sublimation
    - 6. Reaction formation
    - 7. Projection
    - 8. Rationalization
  - C. Neurosis
    - 1. Anxiety reactor
    - 2. Obsessive compulsive
    - 3. Phobia

        4. Conversion reaction
    D. Psychosis
        1. Manic depressive
        2. Schizophrenia
            a. Kallman
            b. Heath
        3. Paranoia
    E. Character disorders
        1. Psychopath
        2. Sexual deviations
            a. Homosexuality
            b. Pedophilia
            c. Beastiality
            d. Fetishism

VIII. The Therapeutic Modification of Behavior
    A. The psychotherapies
        1. Psychoanalysis
        2. Client-centered
    B. Behavior therapies
        1. Desensitization
        2. Aversive techniques
    C. Somatotherapies
        1. Shock
        2. Chemotherapy
    D. Intensive group experience

Texts and References

Ruch and Zimbardo, *Psychology and Life*

Human Relations

HOURS PER WEEK

Class, 3

Course Description

This course is designed as an introduction to the basic principles of sociology, general psychology, and industrial psychology. Major emphasis is placed on such topics as the origin and development of the social body, group behavior, and the problems attendant to leadership and cooperation. Designed to develop a thorough understanding of good human relationships in the industrial complex. The course also proposes to aid in the formation of sound citizenship.

Major Divisions

	Class Hours
I. Human Relations	9
II. Culture, Status	9
III. Working Conditions	12
IV. Racial Attitudes and Misconceptions	9
V. Poverty	3
VI. Discussion and Relation of Outside Reading	6
Total	48

Units of Instruction

I. Human Relations
  A. Family
    1. Generation gap
    2. Symbolic status of "upper class"
    3. The ghetto family
    4. The communal society
    5. The American family and other international families
  B. Education
    1. Student unrest
    2. Causes
    3. Changes as a result of unrest
  C. Government
    1. Civil Rights, Supreme Court
    2. Employment opportunity programs
    3. Law enforcement
    4. School lunch programs
  D. Business
    1. Effects of rent strikes
    2. Retail buying
    3. The college student as a consumer
  E. Religion
II. Culture, Status
  A. Definition
  B. Hospitals' Dual Status System
  C. Stratification, social solidarity and social isolation
III. Working Conditions
  A. Intergroup relations
  B. Assembly line
  C. Capitalistic system
  D. The union worker
  E. The executive
    1. Wages
    2. Workers vs. the executive
IV. Racial Attitudes and Misconceptions
  A. Interracial living
  B. Integration
  C. Racial balance
  D. Biracial integration
  E. Transracial solidarity
  F. Desegregation
  G. Minority groups
V. Poverty
  A. Definition
  B. The poor
    1. Types
    2. Societal reaction
    3. Characteristics
    4. Poverty in relationship to civil law
    5. Possible adaptations to poverty
VI. Discussion and Relation of Outside Reading
  A. Attempt to relate outside required readings to the topics discussed throughout the semester
  B. Relationship of outside reading to everyday life

Texts and References

Bell, *Organization and Human Behavior*
Berne, *Games People Play*
Fraiberg, "Learning To Be Human," *Current Magazine*
Freeman and Kurtz, *America's Troubles: A Casebook of Social Conflict*
Harrington, "America's Racial Crises," *Current Magazine*
______________, *The Other America*
Jerome, "Education for Relevance," *Current Magazine*
Liebow, *Tally's Corner*
Moore, *Vertical Ghetto*

Packard, *Pyramid Climbers*
______________, *Status Seekers*
______________, *Waste Makers*
Peter and Hall, *Peter Principle*

Visual Aids

Motion Pictures:

Children Without. 28 min., 16 mm., sd., b & w. University of Southern California, Audio-Visual Service, Department of Cinema, University Park, Los Angeles, California.
Summary: Deals with the contemporary aspects of poverty.

Come to Life. 10 min., 16 mm., sd., color. Association Films, Inc., 247 Madison Ave., New York, New York.
Summary: A montage which illustrates all that a child sees as its family travels by car. Shows cross sections of all aspects and interests of contemporary society, such as political rallies, dissent, poverty, and free and open spaces.

Confronted. 60 min., 16 mm., sd., b & w. Indiana University, Audio-Visual Center, Bloomington, Indiana.
Summary: Deals with problems of poor people, and the obstacles incurred when a black family moves into an all-white neighborhood.

Have I Told You Lately That I Love You? 24 min., 16 mm., sd., b & w. University of California, Extension Media Center, Educational Films, Berkeley, California.
Summary: Although a sound film, not one word is spoken. This film illustrates our acceptance of and dependence upon mechanical objects and things.

Let The Rain Settle It. 20 min., 16 mm., sd., color. Association Films, Inc., 247 Madison Ave., New York, N.Y.
Summary: Deals with both black and white race relations; the absence of prejudice in children; and an example of an average white father and son needing the assistance of a poor black family.

Still A Brother. 90 min., 16 mm., sd., b & w. McGraw-Hill Book Co., Inc. Text-Film Department, 330 West 42nd St., New York, N.Y.
Summary: This film depicts the problems of the black members of our society. It indicates the geographic limits of prejudice and proves how there are still barriers and walls to the acceptance of minority groups.

BUILDINGS, FACILITIES, EQUIPMENT, AND COSTS

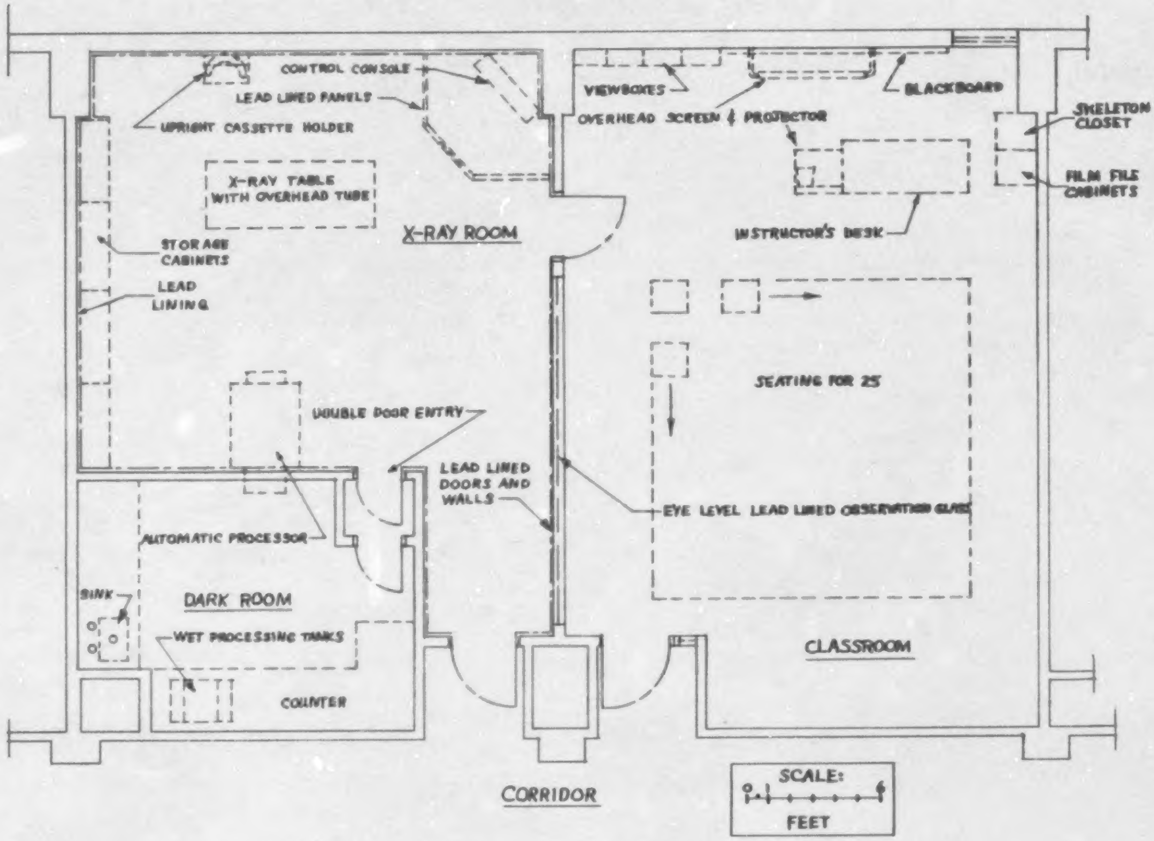
CONTROL CONSOLE
LEAD LINED PANELS
UPRIGHT CASSETTE HOLDER
X-RAY TABLE WITH OVERHEAD TUBE
X-RAY ROOM
STORAGE CABINETS
LEAD LINING
DOUBLE DOOR ENTRY
LEAD LINED DOORS AND WALLS
AUTOMATIC PROCESSOR
SINK
DARK ROOM
WET PROCESSING TANKS
COUNTER
VIEWBOXES
BLACKBOARD
OVERHEAD SCREEN & PROJECTOR
SKELETON CLOSET
FILM FILE CABINETS
INSTRUCTOR'S DESK
SEATING FOR 25
EYE LEVEL LEAD LINED OBSERVATION GLASS
CLASSROOM
CORRIDOR
SCALE:
0
6
FEET

Figure 15.—An example of a simple plan for facilities for a radiologic technology program.

A most important part of planning any curriculum is the consideration of buildings, facilities, equipment, and costs. Administrators, staff, and advisory committees should keep the educational needs described in this guide in mind when planning facilities. Failure to do so can easily result in facilities that are either inadequate or too elaborate to provide optimum instruction.

GENERAL PLANNING

In addition to the preceding general consideration for technical laboratories (see page 50), the educational institution must pay particular attention to specific requirements for housing radiographic equipment. (Note: The advisory committee can offer advice in this regard.)

The use of regular classrooms is recommended for most theory presentation. It is advisable, if possible, to provide limited classroom-type space in conjunction with the radiographic laboratory for use in certain courses involving film critique and review, or in demonstrations requiring the use of specialized equipment.

The following description of facilities may be modified, in conjunction with the advisory committee, to accommodate special situations. Any modification must include the basic equipment and adhere to safety requirements.

PLANNING THE LABORATORIES

The laboratory is designed to accommodate 60 students at near maximum utilization. A laboratory space of approximately 20 x 30 feet (600 sq. ft.) provides sufficient space for the x-ray equipment, automatic processor, darkroom, and occupancy for 8 to 10 students for demonstration. Location of the x-ray table and overhead tube must allow access from all sides. The control console must be located to allow lead shielding of the operator but permit observation of the table through lead-glass windows. The room must have a minimum ceiling height of 9 feet for installation of the overhead tube and support structures.

The darkroom, or developing room, which may be an integral part of the laboratory, or immediately adjoining, is approximately 12 x 16 feet (192 sq. ft.). This space will accommodate the necessary equipment and permit demonstration and supervised practice. The darkroom must be light-tight during processing. In addition, this room must be shielded from x-rays. This is accomplished by lead lining and the use of double door entry or pass boxes installed through the wall. The automatic processor is also installed through the wall of this room. Due to the shielding against light and x-rays in these rooms, an adequate ventilation system is extremely important.

The darkroom must be supplied with hot and cold water sources and drains. In geographical areas where the water from the cold water source is warm in summer, a source of chilled water is desirable. This, in conjunction with a temperature-controlled mixing valve, will insure correct water temperature for the developing tanks.

In addition to the normal electrical service, provision for 230-volt electrical supply must be made for the x-ray generator.

The adjoining special classroom is approximately 20 x 30 feet (600 sq. ft.) and will accommodate 25 students. This room contains view boxes and should provide visual access to the x-ray laboratory through the use of leaded-glass observation ports installed in the common wall of the two rooms. If at any time photographic records of activities conducted with live x-ray is desirable, this may be safely performed from this classroom through the observation windows. Ordinary photographic film is also sensitive to x-rays.

SPECIAL SAFETY REQUIREMENTS

X-ray equipment in use produces radiation. This radiation can be harmful to animal tissue. Repeated exposure to x-rays may result in irreversible damage

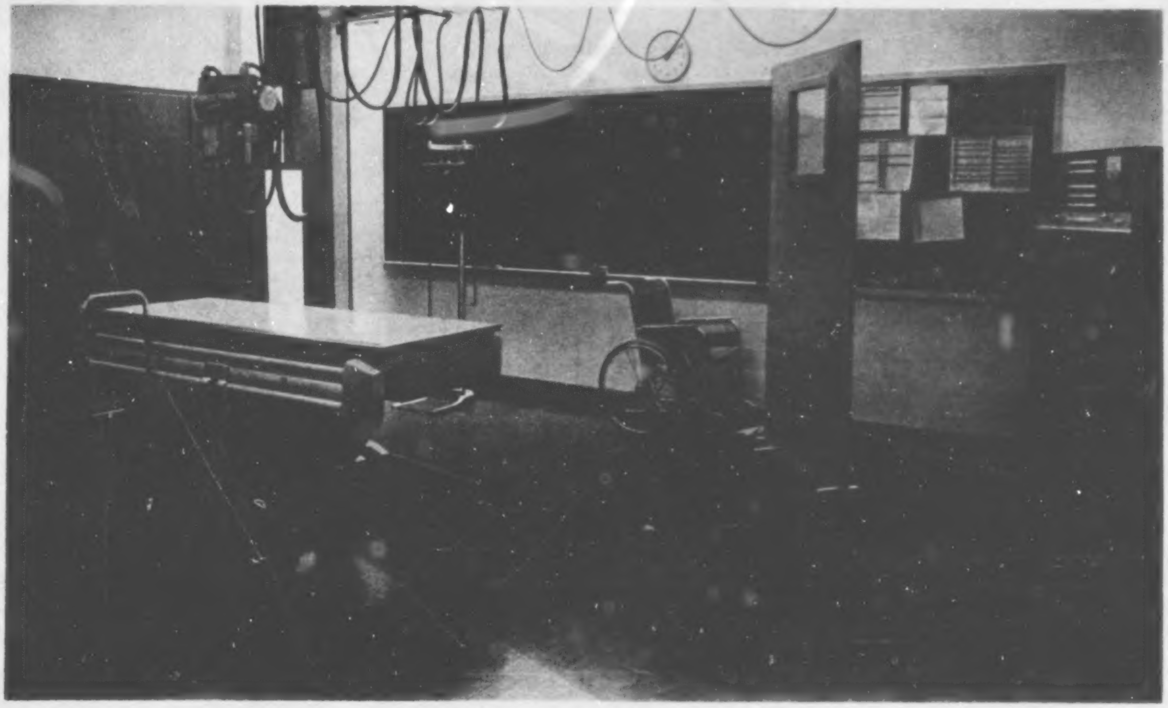

Figure 16.—Equipment for a radiologic technology laboratory should be selected to provide maximum learning experiences.

to the human body. Since the presence of x-rays cannot be determined by any of the human senses, safety precautions must be observed at all times in order to protect persons using the equipment and those who may be in the immediate area. Utilization of proper technique and precaution will completely prevent harmful levels of exposure.

Certain materials have the capacity to absorb x-rays, thus affording protection. In addition, x-rays have a relatively short range; therefore, distance from the point of emission insures protection.

Modern buildings employing concrete or other masonry construction may provide an effective barrier to the undesirable emission of x-rays. This protection will be weakened by doors, windows, cracks, drains or other points which interrupt the continuity of the masonry. For this reason, the most effective barrier to x-rays is lead. The use of lead-lined walls and doors and lead-glass windows provides an extremely effective barrier. Lead lining is not necessary for walls located in a position where people would not normally be in proximity to the other side of the wall. Thus, outside walls on upper floors would be exempt, as would ceilings on top floors and floors having no access beneath them. In addition to the protection of personnel, lead shielding must be used to protect unexposed film stored in the laboratory area or film being processed in the darkroom.

The wearing of film badges by any personnel routinely using the x-ray laboratory should be emphasized as a safety measure. A rack for these badges may be provided at a location convenient to the laboratory, but on the "safe" side of the lead shielding.

Since x-ray equipment is heavy, attention must be paid to load-bearing capacities of the building. If the laboratory is planned in conjunction with new construction, the specifications needed to provide safe load-bearing capacities for floor and ceiling

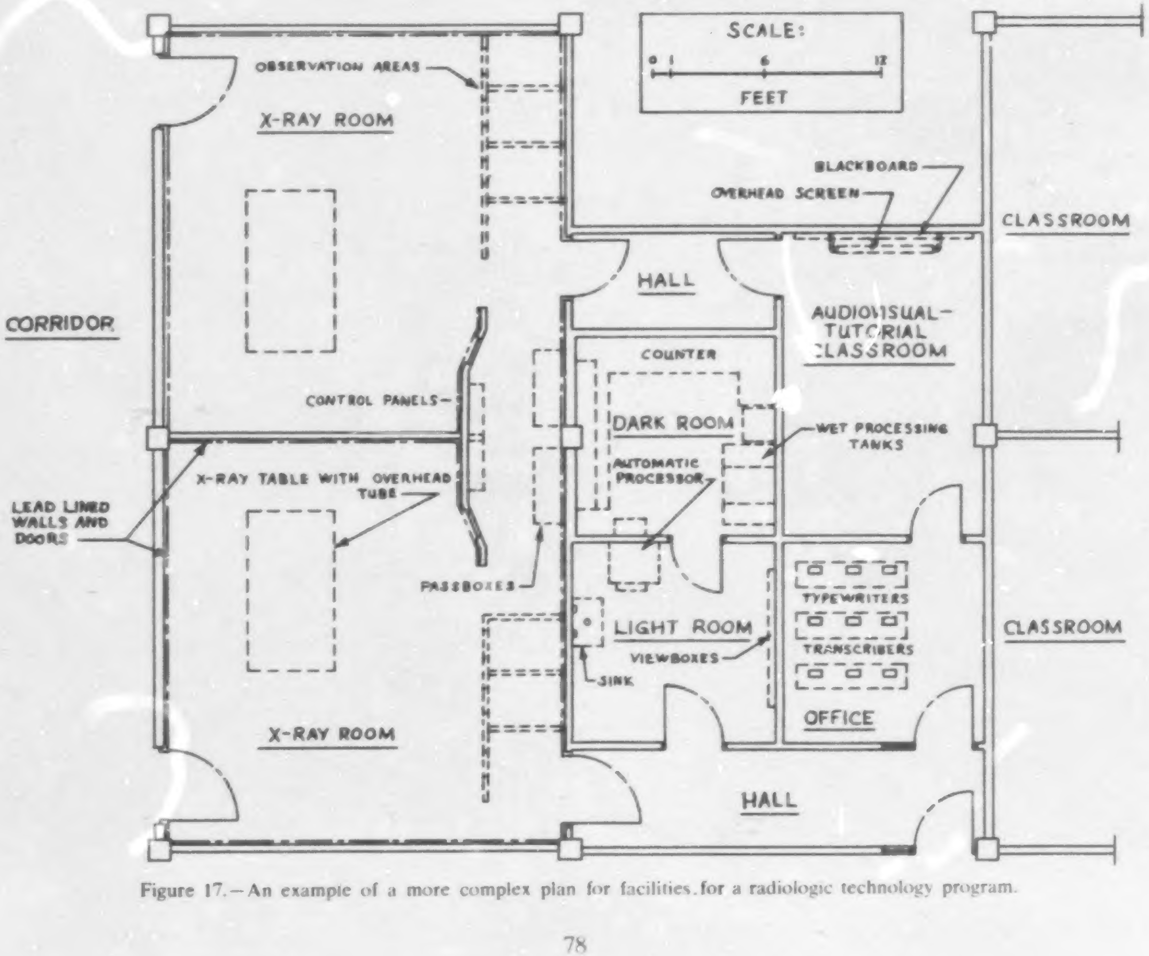
OBSERVATION AREAS
X-RAY ROOM
SCALE:
0 1 6 12
FEET
BLACKBOARD
OVERHEAD SCREEN
CLASSROOM
HALL
AUDIOVISUAL-TUTORIAL CLASSROOM
CORRIDOR
COUNTER
CONTROL PANELS
DARK ROOM
WET PROCESSING TANKS
AUTOMATIC PROCESSOR
X-RAY TABLE WITH OVERHEAD TUBE
LEAD LINED WALLS AND DOORS
PASSBOXES
TYPEWRITERS
TRANSCRIBERS
LIGHT ROOM
VIEWBOXES
SINK
CLASSROOM
X-RAY ROOM
OFFICE
HALL

Figure 17.—An example of a more complex plan for facilities for a radiologic technology program.

should be included.

Installation of this equipment in existing buildings requires attention to the load-bearing capacities of floors and ceilings as well as the modifications to supply lead shielding and adequate electrical power. Should the ceiling of the room prove incapable of supporting the overhead x-ray tube, support beams may be installed for this tube. This installation transfers the load to the floor and requires additional ceiling height over the minimum previously mentioned.

SUGGESTED AUDIOVISUAL EQUIPMENT

Listed below are the names, addresses, and approximate costs of teaching aids which are recommended or considered optional for a radiologic technology program. The names and addresses of companies are listed only as a guide to the administrator in the purchasing of these items. It is not intended to stress the purchase from a particular company, and any equivalent items available through other dealers would be just as satisfactory. The costs are based upon the listed price (1972) as advertised by each respective company at the time of developing this publication. An estimated cost has been used where a listed price was not available. It is possible that the anatomy department of a community college would have some of the suggested anatomy equipment listed; therefore, consideration could be given to making arrangements for cooperative sharing of the appropriate equipment. Projectors, screens, and other audiovisual equipment are assumed to be available for use; therefore, no provision is made in this estimate for these items.

Denoyer-Geppert
5235 Ravenswood Ave.
Chicago, Ill. 60640

Quan.	*Item*	*Recommended*	*Optional*
1	Torso and head model	$ 550	$ -
1	Plastic skeleton	250	-
1	Anatomy charts (set)	250	-

Medi Visuals, Inc.
Suite 1812
342 Madison Ave.
New York, N.Y. 10017

	Overhead transparencies		
1	Chemistry (set)	-	200
1	Human biology (set)	150	-
1	Atomics (set)	40	-
1	Electricity (set)	50	-
1	Physics (set)	125	-
1	Positioning (set)	300	-
1	Transparency file box	-	5

Alderson Research Laboratories
390 Ludlow St.
Stamford, Conn. 06904

1	Rando phantom series for radiotherapy	-	4,000
1	Dental x-ray teaching and training replica	-	4,000
	Alderson nuclear phantom	-	4,000
1	Alderson radiography phantom	4,000	-

	Nuclear Associates, Inc. 35 Urban Ave. Westbury, N.Y. 11590		
1	3M x-ray phantom, disarticulated (complete set)	-	5,000
	Field Emission Corporation Melrose Ave. at Lincke St. McMinnville, Ore. 97128		
1	Field Emission x-ray machine	-	2,000
	Heath Company Benton Harbor, Mich. 49022		
1	Heath x-ray machine simulator, includes oscilloscope	400	-
	Estimated total costs	$ 6,115	$19,205

SUGGESTED LABORATORY EQUIPMENT AND SUPPLIES

The following equipment, supplies, and costs are representative of the initial establishment and maintenance of a single radiologic technology laboratory. Not all of the equipment and supplies listed are necessary to fulfill the laboratory objectives; they have been included to provide a comprehensive listing of available items which may be purchased if desired. The cost of the items below is an average estimated cost (1972) at the time of developing this publication. The estimates are based upon the purchase price of new and modern equipment and supplies of good quality.

EQUIPMENT

Quan.		*Recommended*	*Optional*
1	Mobile unit (15 MA)	$ -	$ 3,500
1	Vertical bucky stand	-	2,300
1	Head unit	-	10,700
1	Body section unit	-	4,000
1	Overhead tube and track	8,500	-
1	Radiographic table	6,600	-
1	Radiographic and fluoroscopic table	-	14,000
1	Generator (300 MA, 125 KVP)	6,700	-
1	Automatic processor	9,100	-
1	Image intensifier, TV and 70 mm. camera	-	28,500
1	Verticle cassette holder	150	-

1	Manual processing tank, includes 3 insert tanks	2,400	-
1	Film dryer	250	-
1	Sectional darkroom cabinets, (complete set)	1,300	-
1	Film storage bin	115	-
1	Cine film processor	-	6,000
2	Chemical storage tanks and lids	150	-
	Estimated total costs	$35,265	$69,500

SUPPLIES

1	Film markers (complete set)	$ 50	$ -
1	Film identification printer	110	-
1	Half film blocker (complete set)	40	-
1	Cassette, 5" x 7"	20	-
1	Cassette, 8" x 10"	25	-
1	Cassette, 10" x 12"	30	-
1	Cassette, 11" x 14"	35	-
3	Cassettes, 14" x 17"	120	-
1	Cassette, phototiming, 8" x 10"	26	-
1	Cassette, grid, 14" x 17"; 80 line, 12:1 ratio, 30"—72" focal range	350	-
1	Cassette, curved	60	-
1	Intensifying screen for 5" x 7" cassette	10	-
3	Intensifying screens for 8" x 10" cassette	80	-
1	Intensifying screen for 10" x 12" cassette	35	-
1	Intensifying screen for 11" x 14" cassette	40	-
4	Intensifying screens for 14" x 17" cassette	300	-
1	Fluoroscopic screen	-	50
1	Multi-section polytomography cassette	-	250
1	Stationery grid, 10" x 12"	275	-
1	Non-screen film holders (complete set)	30	-
3	X-ray film developing hangars, 5" x 7"	20	-
5	X-ray film developing hangars, 8" x 10"	30	-
5	X-ray film developing hangars, 10" x 12"	30	-
5	X-ray film developing hangars, 11" x 14"	30	-
5	X-ray film developing hangars, 14" x 17"	30	-
1	Film hangar storage rack	28	-
1	Mechanical interval timer	22	-
1	Electric interval timer	-	45
1	Processing tank cleaning brush	4	-
2	Processing mixing paddles	10	-

1	Darkroom apron	5	-
-	Lightproof shades (cost varies according to window size)	X	-
1	Floating thermometer	3	-
1	Lightproof ventilator	200	-
2	Safelights and filters	80	-
1	Silver recovery unit	-	600
-	Film processing chemicals (cost varies according to usage)	X	-
1	X-ray caddy radiograph carrier	-	66
1	Film corner cutter	-	40
-	Filing envelopes (cost varies according to quantity needed)	X	-
-	Filing cabinets (cost varies according to quantity needed)	X	-
1	Leaded apron	70	-
1	Leaded gloves (pair)	70	-
1	Patient's apronette	-	25
1	Apron and glove rack	30	-
1	Patient protector shield	-	85
1	Cassette pass box	275	-
1	Cassette pass box installation accessories	-	20
1	Lead-lined film chest	-	95
1	Barium sulfate (25 lb. pkg.)	-	10
1	Hand stereoscope	-	70
1	High intensity spotlight	-	60
1	Dental film viewer	-	60
1	Dental film viewer	-	45
1	Mobile illuminator stand	175	-
1	Radiograph duplicator	-	600
-	Duplicating film (cost varies according to quantity used)	-	X
1	Smaller cassette adapter	-	40
1	Vertical cassette holder for cross-table radiography	-	75
1	Accessory rack	-	75
1	Sandbag set	15	-
1	Penumatic compression paddle	-	65
1	Foam positioning blocks (set)	40	-
1	Angligner	20	-
1	Caliper	10	-
1	Step stool	25	-
1	Step wedge penetrometer	45	-
1	Barium mixer	-	85
1	Colon air insufflator	-	17
-	Disposable enema tips (cost varies according to quantity needed)	-	X
1	Enema hose	-	5
1	Barium enema container	-	25
1	Barium enema cut-off	-	20
1	Bardex enema tube and bulb	-	10
1	Pneumocolon	-	35

1	Dark adapter goggles	-	5
1	Mammography cone	-	80
1	Extension cylinder	-	85
1	Head immobilizer	-	235
1	Pelvimeter (Colcher-Sussman)	-	40
1	Y tube and tip	-	8
1	Polaroid processing unit	-	900
1	Polaroid cassette	-	200
-	Film, 5" x 7", 100 sheets	15	-
-	Film, 8" x 10", 100 sheets	30	-
-	Film, 10" x 12", 100 sheets	45	-
-	Film, 11" x 14", 100 sheets	60	-
-	Film, 14" x 17", 100 sheets	80	-
	*Estimated total costs	$ 3,173	$ 4,066

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*These costs were based on 1972 quotes and are considerably higher at the present time.

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Appendix A

THE AMERICAN REGISTRY OF RADIOLOGIC TECHNOLOGISTS[1]

Training In Radiologic Technology

The function of accrediting of schools of radiologic technology is provided by the Council on Medical Education of the American Medical Association. Schools of x-ray technology are inspected, approved, and officially listed by the A.M.A. Similar formal systems of accreditation of schools of nuclear medicine technology and radiation therapy technology are being developed.

Career information and latest listings of A.M.A.-approved schools of x-ray technology may be obtained from the American Society of Radiologic Technologists at 645 N. Michigan Ave., Chicago, Illinois 60611.

REGISTRATION IN X-RAY TECHNOLOGY

General Qualifications of Trainees:

Applicants for training leading to registration in x-ray technology must be citizens of the United States or shall have filed a Declaration of Intention or a Petition for Naturalization for United States citizenship (see Appendix H); may be male or female; must have had a high school education, or the equivalent thereof.

Eligibility Requirements:

Applicants must have successfully completed a program of formal training which has been approved by the Council on Medical Education of the American Medical Association.

Applicants receiving parts of the training in more than one A.M.A.-approved school must have satisfactory recommendations from each supervising radiologist as to the applicable time spent in training under his supervision.

All of the training must be within an A.M.A.-approved program of training. No credit is allowed for students admitted to a program on an advanced level due to previous experience in x-ray technology.

X-ray Technology Examinations:

Group examinations are held semi-annually throughout the United States the first weekend of May and November. A written examination shall be required in the subjects of Radiographic Techniques, Standard Positioning, Anatomy and Physiology, X-ray Physics and Electricity, The Darkroom, Special Procedures, Radiation Protection, Medical Terminology, Professional Ethics and Related Nursing. The questions for the examination shall be prepared and selected by the Board of Trustees and will be sent under seal to the radiologist appointed to supervise the examination. All examinations are copyrighted. All persons are prohibited from copying or reproducing the questions without written permission of the Registry Office.

Certification in X-ray Technology:

To those who have passed the examination in X-ray Technology and are otherwise eligible, a certificate shall be issued which confers upon the applicant the right to use the title "Registered Technologist" and its abbreviation "R.T." in connection with the student's name so long as the certificate shall be in effect.

Correspondence for the American Registry of Radiologic Technologists should be addressed to: The American Registry of Radiologic Technologists, 2600 Wayzata Boulevard, Minneapolis, Minnesota 55405.

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[1] Adapted from The American Registry of Radiologic Technologists brochure.

Appendix B

CONTRACTUAL AGREEMENT

In all instances of hospital-college affiliation, there should exist a very definite written contractual agreement signed by representatives of both the college and clinical agency. The content and form of the contract should be general enough to permit flexibility to make minor modifications in the conduct of the program, yet sufficiently specific to clearly demonstrate to each agency major responsibility for the clinical phases and activities of the program.

Unless required by law, the final contract need not be a legal document to the degree that it becomes enforceable to the letter. In fact, such a document would be undesirable if, for mutually acceptable reasons, the agreement should require revision or termination. On the other hand, the contract should not be so vague or ambiguous as to be a useless guide for either institution.

The principle headings should be:

1. Specific responsibilities of the college
2. Specific responsibilities of the clinical agency
3. Mutual responsibilities

Some of the areas that should be included under these headings are:

1. The formal responsibility for the educational program
2. The extent to which the college seeks to use the extended campus resource
3. The management of disciplinary affairs
4. The extent to which the hospital provides resources and adjunct instructional staff
5. The health requirements of and procedures to be followed by students and instructors
6. The management of medical emergency problems of students and instructors while in the clinical facilities
7. The provision of class, conference and office space, locker or dressing rooms, and dining arrangements
8. The extent to which students and instructors would be expected to comply with the hospitals' rules and regulations
9. The arrangements for legal protection of students and instructors while they are in the clinical agency

Periodic review of contracts should be planned to determine their continuing relevancy to the objectives and goals of the health technology programs. Such documents cannot serve indefinitely because the curriculums they reflect will not remain static.

Appendix C

GLOSSARY

ACCREDITATION—Accreditation is the process by which an agency or an organization evaluates and recognizes a program of study or an institution as meeting certain pre-determined qualifications or standards. Accreditation shall apply only to institutions and programs.

CERTIFICATION—Certification is the process by which a non-governmental agency or association grants recognition to an individual who has met certain pre-determined qualifications specified by that agency or association.

COBALT THERAPY—Medical treatment of disease using radioactive cobalt.

EXPOSURE FACTORS—The technical factors used to subject an x-ray film to the effects of x-ray.

GASTROINTESTINAL—Pertaining to the stomach and intestines.

IONIZING RADIATION—Emission of radioactive rays which induces, either directly or indirectly, ionization of radiation-absorbing material.

LICENSURE—Licensure is the process by which an agency of government grants permission to persons meeting pre-determined qualifications to engage in a given occupation and/or use a particular title, or grants permission to institutions to perform specified functions.

NUCLEAR RADIATION—Radiant energy emitted from the nucleus of an atom.

OPAQUE MEDIA—A material which cannot be penetrated by x-ray; used to outline certain regions of the body.

PARAMEDICAL PERSONNEL—Personnel employed to supplement the work of medical personnel.

PHANTOM—A model of the body, or one of its parts, used in lieu of a human being in the practice of radiologic technology.

PRACTICUM—Practical experience in a hospital department of radiology.

QUALITATIVE RADIATION—The kind of radiation being utilized.

QUANTITATIVE—The amount of radiation used.

RADIANT ENERGY—Process by which energy is transmitted through space and matter.

RADIATION—The projection through space of any form of electro-magnetic waves.

RADIATION DIAGNOSIS—Conclusion reached as to determination of disease by the use of radiant energy.

RADIOACTIVE ISOTOPES—Spontaneous emission of radiation from chemical elements which have the same atomic number but different mass numbers.

RADIOGRAPH—A photographic film which has been exposed to x-rays after they have passed through a part to be examined.

RADIOGRAPHY—The science which deals with the taking of x-ray films.

RADIOISOTOPES—Radioactive forms of chemicals, such as radioactive cobalt.

RADIOLOGY—The science which deals with the use of all forms of radiant energy in the diagnosis and treatment of disease.

REGISTRATION—Registration is the process by which qualified individuals are listed on an official roster maintained by a governmental or non-governmental agency.

SCANNER—A unit which records, on a photographic plate, the emission of radioactive waves from a specific substance injected into the body.

URINARY TRACT EXAMINATION—Radiographic study of the kidneys, ureter and bladder.

Appendix D

ORGANIZATIONS CONCERNED IN EDUCATIONAL PROGRAMS IN RADIOLOGIC TECHNOLOGY

THE COUNCIL ON MEDICAL EDUCATION of the American Medical Association

THE JOINT REVIEW COMMITTEE ON EDUCATION IN RADIOLOGIC TECHNOLOGY

THE AMERICAN COLLEGE OF RADIOLOGY and its Commission on Technologist Affairs

THE AMERICAN SOCIETY OF RADIOLOGIC TECHNOLOGISTS

THE AMERICAN REGISTRY OF RADIOLOGIC TECHNOLOGISTS

THE AMERICAN MEDICAL ASSOCIATION, through the Council on Medical Education, is the organization recognized by the U.S. Commissioner of Education as the responsible accrediting agency for educational programs for specific health disciplines. The Council seeks to establish and maintain standards of quality for educational programs, provides recognition of educational programs which meet the standards established, and encourages and assists in the development of new programs. The Council receives recommendations made by the Joint Review Committee.

THE JOINT REVIEW COMMITTEE ON EDUCATION IN RADIOLOGIC TECHNOLOGY considers and takes action on all matters related to educational programs in radiologic technology which are referred to it by any of the agencies listed above, or by hospitals or educational institutions and, in turn, makes recommendations to the Council regarding the standards of programs in radiologic technology. The Joint Review Committee is composed of three radiologists appointed by the American College of Radiology and three technologists appointed by the American Society of Radiologic Technologists. A Secretary to the Joint Review Committee acts as executive officer and assists in the fulfillment of its responsibilities. The Joint Review Committee examines applications and records of educational programs, and reviews the performance (on examination) of graduates of such programs. It requests site evaluations when indicated, reviews the survey reports and makes recommendations to the Council as to approval status. The Joint Review Committee may act in an advisory capacity to institutions initiating new programs, or as an advisor to existing programs in any manner which may be helpful in elevating the quality of education.

THE AMERICAN COLLEGE OF RADIOLOGY, through its Board of Chancellors and Council, considers and takes action on all matters related to technologist affairs which are referred to it by any of its commissions or committees. The ACR may make suggestions and recommendations to any of the collaborating organizations, and specifically, to the Joint Review Committee whenever it feels it can be of assistance. The ACR furnishes a list of qualified radiologists who are available for service to the Joint Review Committee for surveys and reviews of programs.

The Commission on Technologist Affairs acts as an advisory body to the ACR, and cooperates with both the ASRT and ARRT regarding problems which are related to technologist affairs, and specifically regarding the broad principles and details of educational programs.

THE AMERICAN SOCIETY OF RADIOLOGIC TECHNOLOGISTS, through its Board of Directors, considers and takes action on all matters related to educational programs referred to it by any of its committees. The ASRT may make suggestions and recommendations to any of the organizations herein enumerated, and specifically to the Joint Review Committee whenever it feels it can be of assistance. The ASRT furnishes a list of qualified radiologic technologists who are available for service to the Joint Review Committee for surveys and reviews of programs.

THE AMERICAN REGISTRY OF RADIOLOGIC TECHNOLOGISTS is the organization which evaluates the proficiency of graduates of approved educational programs in radiologic technology. The ARRT Board of Trustees composed of four radiologists appointed by the ACR and four radiologic technologists appointed by the ASRT, prepares and conducts examinations for graduates of A.M.A.-approved educational programs and issues certificates of registration to candidates who successfully pass the examination.

Correspondence for the JOINT REVIEW COMMITTEE ON EDUCATION IN RADIOLOGIC TECHNOLOGY should be addressed to:

Robert L. Coyle, B.S., R.T., Executive Director
307 North Michigan Avenue
Suite 1801
Chicago, Illinois 60601
(312) 726-9150

The addresses of cooperating organizations are as follows:

Department of Allied Medical Professions and Services
Division of Medical Education
American Medical Association
535 North Dearborn Street
Chicago, Illinois 60610

The American College of Radiology
20 North Wacker Drive
Chicago, Illinois 60606

Robert C. Best, Executive Director
The American Society of Radiologic Technologists
500 N. Michigan Avenue
Chicago, Illinois 60611
(312) 467-5840

Appendix E

EVALUATION PROCEDURES FOR COLLEGE SPONSORED PROGRAMS IN RADIOLOGIC TECHNOLOGY

In accordance with practices of regional and other professional accrediting agencies, the American Medical Association Council on Medical Education conducts its accreditation program largely through mechanism of a "visiting committee," or survey team. Individuals are appointed to survey teams for educational programs in radiologic technology by the Joint Review Committee on Education in Radiologic Technology, and are responsible for the conduct of site visits to educational institutions which have applied for approval of teaching programs. The survey team is responsible for the preparation of reports to be submitted for Joint Review Committee action and preparation of recommendations on approval status for consideration of the Advisory Committee on Education for the Allied Health Professions and Services, and subsequent final action of the Council on Medical Education.

The Joint Review Committee on Education in Radiologic Technology is composed of three representatives from each of the following organizations: The American College of Radiology and The American Society of Radiologic Technologists.

Site visit survey teams ordinarily consist of two individuals from different clinical settings; a qualified radiologist and a registered (ARRT) radiologic technologist, both with experience in teaching programs. Occasionally, the survey team may be accompanied by an A.M.A. staff observer or, with the permission of the sponsoring institution, observers representing other agencies with a special interest in the field of radiologic technology.

At the direction of the Joint Review Committee, the staff projects an annual evaluation schedule based on the following:

1. Graduation date established for the first class for new programs.
2. Elapsed time interval between the last site visit and the current calendar year.
3. Evaluation recommendations from previous site visits that require re-surveys in less than the normal revaluation interval.
4. Requests for re-surveys by program directors or the chief administrative officer of sponsoring institutions.

The sponsoring institution is advised of the names of survey team members. One member of the survey team is requested to contact both the co-surveyor and the educational institution to determine a mutually satisfactory date for the site visit. Ordinarily, these arrangements are made at least thirty days prior to the site visit.

Prior to the site visit, members of the survey team are provided detailed information concerning the teaching program, prepared by the sponsoring institution. This information includes the administrative and organizational pattern of the sponsoring institution, academic and administrative policies, operating finances, admissions data, faculty qualifications, curriculum content, description of physical facilities (including library), relationships with teaching affiliates, and research. Survey team members are requested to review this material carefully prior to the site visit.

Evaluation procedures include the following:

1. An executive session of the survey team to review the information provided by the sponsoring institution and proposed schedule for the visit.
2. Conferences with the program director including discussion of curriculum, faculty, supervised clinical experience, financial support, and administrative relationships within the institution. This conference is arranged so that the visiting committee may identify and become oriented to particular problems. It is also to orient the program director to the methods and procedures of the visiting committee.
3. Tour of the teaching facilities of sponsoring institution and affiliated hospitals.
4. Conferences with department chairmen and all faculty members with major teaching or administrative responsibility.
5. Conference with clinical teaching supervisors from all affiliated hospitals.
6. Conference with a reasonable proportion of students enrolled in the educational program, with selection to be by a method endorsed by the survey team.

7. Conference with the chief administrative officer of the parent institution or an appointed representative.

In addition to pre-scheduled conferences with administrators and faculty, visiting committees review the following materials and data:

1. Statement of the aims and objectives of the educational program conducted by the sponsoring institution, as well as the general educational objectives and purposes of the parent institution and hospital affiliates.
2. Course outlines and other materials describing curriculum content.
3. List of text books, laboratory manuals and other reference material used in the teaching program.
4. Quizzes, mid-term and final examinations, term papers, and special study assignments.
5. List of research projects related to radiology and radiological technology currently in progress at sponsoring institution and affiliated hospitals.
6. Enumeration of procedures indicating volume and variety of clinical material available for teaching purposes at each affiliated hospital.

Site visit evaluation reports are submitted to the Joint Review Committee on Education in Radiologic Technology for consideration and preparation of a specific recommendation concerning approval status. The Joint Review Committee's recommendation is transmitted to the Advisory Committee on Education for the Allied Health Professions and Services and subsequently to the A.M.A. Council on Medical Education at its next scheduled meeting. Either the Advisory Committee or the Council may elect to endorse the recommendation of the Joint Review Committee, or may request further information if the recommendation cannot be substantiated by the site visit evaluation report and information provided by the sponsoring institution.

If the Council on Medical Education elects to withhold or withdraw approval status of an educational program, based upon a recommendation of the Joint Review Committee, the sponsoring institution may appeal this decision either through the channels of the Joint Review Committee or directly to the Council on Medical Education.

The Council on Medical Education is responsible to the A.M.A. and to the profession to announce approval status of educational programs for the Allied Medical Professions and Services. These announcements are also of importance to registries and certifying boards, as well as to individuals seeking admission to educational programs. The Council publishes annually the Directory of Approved Allied Medical Educational Programs.

Appendix F

IDENTIFICATION OF THE SPONSOR OF AN EDUCATIONAL PROGRAM

The Joint Review Committee accepted the A.M.A.-approved policy on the identification of the sponsor of an educational program. The policy lists seven criteria for determination of the sponsor which are actually seven statements of key functions of a program sponsor. The criteria are applicable to programs in hospitals and colleges. The policy:

1. Institution assumes primary responsibility for curriculum planning and selection of course content, in consultation with representatives of affiliating clinical facilities.
2. Institution exercises primary responsibility in coordination of classroom teaching and supervised clinical experience in simulated patient care facilities as well as affiliating clinical institutions.
3. Institution appoints faculty to program based on established criteria for eligibility, including professional and academic qualifications.
4. Institution demonstrates evidence of sound financial support on a current and continuing basis.
5. Institution receives and processes applications for admission to program; has established an admissions committee with representation from both didactic and clinical aspects of program; acknowledges receipt of applications and advises applicants promptly of action taken.
6. Accepted applicants are enrolled as full- or part-time students with all customary privileges for use of available library facilities, athletic facilities, and student health facilities, and may participate in extracurricular social and athletic events on the same basis as other full-time students.
7. Institution grants degree or certificate, or other official evidence of completion of program.*

The JRC requests new programs and programs changing their structure to clearly identify the program sponsor. For further definition and recommendations, see the *Essentials of an Accredited Educational Program for Radiologic Technologists, AMA, 1969,* and *The Organizational Guide for College-Sponsored Programs in Radiologic Technology, Council on Medical Education, June, 1973.*

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*Military Medical Departments are considered to be program sponsors although they may be affiliated with civilian educational institutions for the purposes of obtaining academic credit—as long as this does not jeopardize a university's accreditation status or transcend regional accreditation.

Appendix G

PROCEDURE FOR ACCREDITATION

1. Appropriate forms for submission of the initial application may be obtained from the Joint Review Committee on Education in Radiologic Technology, 307 North Michigan Avenue, Suite 1801, Chicago, Illinois 60601, or the Council on Medical Education of the American Medical Association, Department of Allied Medical Professions and Services, 535 North Dearborn Street, Chicago, Illinois 60610. Requests for the forms should contain a brief description of the type of program so that proper applications for approval and organizational information can be returned.
2. The forms should be completed as requested and signed by the administrative officers of the facility sponsoring the program and the affiliates of the educational program.
3. The dates that the forms are received by the Joint Review Committee shall be the date considered for conformance with this policy.
4. The Joint Review Committee will review the application for completeness* and request additional or supplementary information as may be required.
5. When the applications are in order, a preliminary site visitation of the program will be scheduled according to Joint Review Committee policy.
6. The findings of the Joint Review Committee and recommendations based on these findings will be returned to the appropriate officials of the program.
7. The program officials may respond to the initial statement of findings and recommendations.
8. The application material, site visitation report, recommendations and response of the program officials will be submitted to the Joint Review Committee for action.
9. The official recommendation of the Committee will be sent to the program officials and the Council on Medical Education of the American Medical Association.
10. The Council on Medical Education will take final action on the recommendation of the Joint Review Committee, and notify the program officials in accordance with the policies of the Council on Medical Education.
11. Appeals of decisions can be made by the administrative officer of the program or designated first to the Joint Review Committee, second to the Council on Medical Education.

The policy carries no sanctions, as such. In effect, the policy requires the prompt processing of initial applications by the JRC and advises the programs of real risks in admitting students to a program without reasonable assurance that the application is acceptable. The importance of this lead time is expected to be emphasized when program self-study becomes a part of the application and accreditation procedure.

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Appendix H

*REGISTRY REQUIREMENT CHANGE, 1974

An amendment to Registry bylaws has been approved by The American Society of Radiologic Technologists and the American College of Radiology, which eliminates the United States citizenship requirement from all Registry eligibility requirements. Future candidates for certification will not be required to be citizens of the United States.

Present holders of ARRT Certificates of Achievement, who have met all other Registry requirements and who have succeeded on the examination, will be issued the regular ARRT Certificate of Registration without any additional procedure on their part.

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